MACHINERY.

VOL. 2. August, 1896. No. 12.

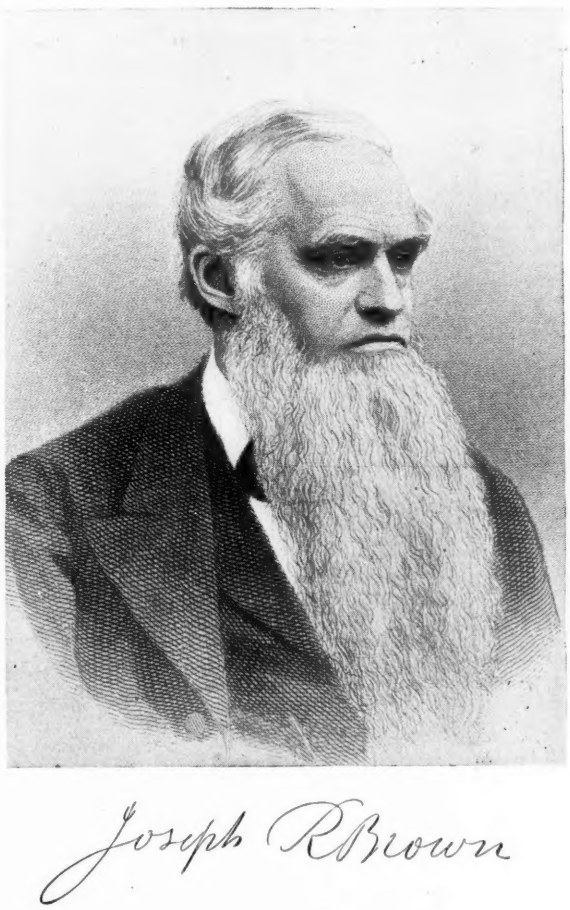
THE UNIVERSAL MILLING MACHINE.

THE "Universal Milling Machine," now so widely and favorably known in the modern machine shop, was invented by Joseph R. Brown, of Providence, R. I., in the year 1861, and patented February 21, 1865.

The first machine was sold to the Providence Tool Co., March 14, 1862, and was used in making the special tools for the manufacture of rifles for the United States Government, from whom they had a contract at that time.

In 1858 the firm of J. R. Brown & Sharpe commenced the manufacture of the Wilcox & Gibbs sewing machine, and the desirability of a tool for performing some of the operations upon the parts of this machine and the various special tools needed for their accurate and economical manufacture, led to the designing of this machine, which at once proved itself well adapted to a great variety of work and especially valuable from the facility with which it could be changed from one job to another.

Its value soon became known among manfacturers of firearms and sewing machines, who were the first to appreciate its merits, and it has since been used in many other lines of manufacture, till it is now well understood that no first class machine shop can afford to be without one or more of these machines. It was the first of a line of machine tools put on the market by the Brown & Sharpe Manufacturing Co., many of which they originated and all of which were the outgrowth of the needs of their own business.



The illustration shown on the next page was made from a photograph of the original machine, which is now in the possession of its makers. The "Universal" milling machine proved so popular that it was imitated in Canada and in Europe, and but very little change has been made since 1862 in its general design and principal features. There is a constantly increasing demand in Europe for these machines in competition with those made there, which are nearly exact copies. This is doubtless occasioned by the difference in the accuracy of the tools, both in construction and in the alignment of the different parts.

Joseph R. Brown, whose portrait appears herewith, was born in Warren, R. I., on the 26th of January, 1810. He learned the trade of a machinist and subsequently that of a watchmaker. In 1832 he joined his father, David Brown, commencing business on South Main street, in Providence, R. I., making lathes and small tools, and repairing clocks and watches. In 1841 he dissolved partnership with his father and conducted the business entirely alone till 1853, when Lucian Sharpe, who had commenced as his apprentice five years before, became a partner under the firm name of J. R. Brown & Sharpe. The later history of the firm need not be mentioned here, as it is well known and their line of milling and other machines is very complete.

Mr. Brown died at the Isles of Shoals, N. H., July 23, 1876.

* * *

THICK CYLINDERS.

F. F. HEMENWAY.

In relation to what was said in the July issue on the subject of "Strength of Hydraulic Cylinders," and the article following, "Rule for Safe and Bursting Strains of Tubes, Pipes and Hollow Cylinders," in which discussion I was rather unexpectedly made to take part, I wish to say right here that in what follows there is no intention of extenuating, or in trying to substantiate what I said, further than I have already done, or of controverting what Mr. Cooper has said. It is the truth we all want, and that is just what is not entirely easy to get at when the matter comes to a question of cylinders for restraining high pressures. Mr. Cooper and myself, however, disagree so materially, that I think a word further in the way of explanation on my part will not be out of order; nothing more than a word towards the end of making us all see alike.

I used Barlow's formula because the results from its employment may be said to be identical with those that obtained in the practice which brought about the wholesale breaking of the cylinders of the Bramah presses used in the attempt to launch the *Leviathan.* Not only one of these cylinders failed, but they failed one after the other at the pressure named, just as Barlow's formula indicates that they should have failed.

It appears to me that Barlow is further fortified by the example Mr. Cooper gives in the July issue. A cylinder 8 inches radius and 8 inches metal, burst under a pressure of 6 000 pounds. Applying Barlow's formula and using 18 000 pounds as the ultimate cohesive strength of the material, we have:

$$P = \frac{18\,000 \times 8}{8 + 8} = 9\,000$$

pounds per square inch as the breaking pressure—the pressure at which the cylinder should have broken.

Hodghinson says that 15 000 instead of 18 000 should be used as the ultimate cohesive strength of cast iron, and Trautwine adopted that for pipes. But I believe that with such iron as would be used in hydraulic cylinders, 18 000 pounds may be employed.

Mr. Cooper says of this cylinder that "the material must have suffered from the effects of unequal strains, which could hardly fail to be the case with any cylinder as thick as this unless rather

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unusual pains were taken in cooling. As it is, it broke at 6 000 pounds; by Barlow's formula it should have held 9 000 pounds, a result that not infrequently obtains in thick iron castings. The strains need not have been *very* unusual.

The assumption that the same rule applies to thick as to thin cylinders is, of course, not correct. Thus, Box points out by way of illustration, that in the instance of a 10 inch cylinder a thickdess of 10 inches gives a strength only four times greater than a thickness of 1 inch.

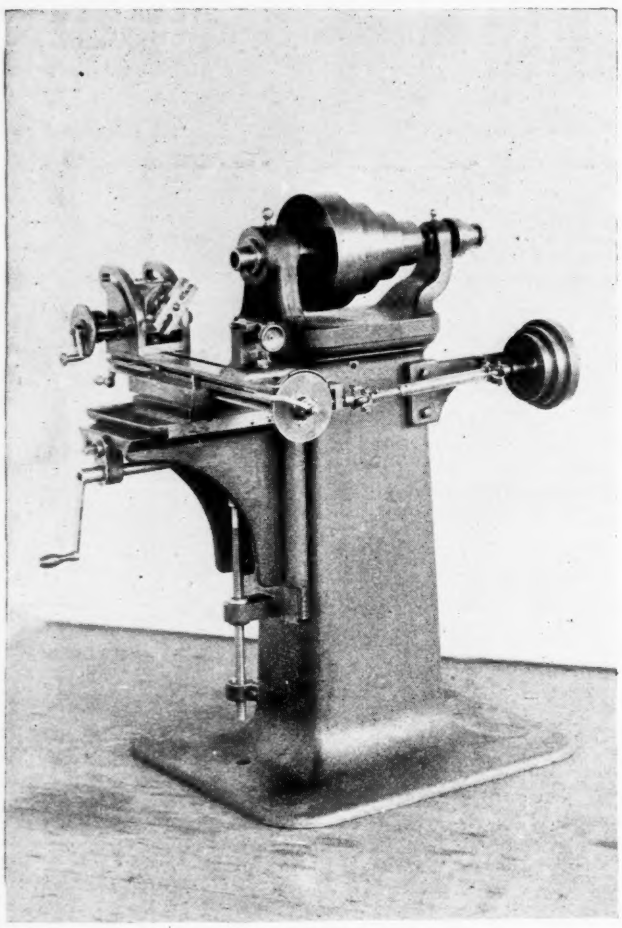
Regarding thick cylinders, Rankine has this:

$$\frac{R}{r}=\sqrt{\left\{\frac{f+p}{f-p}\right\}}$$

in which expression R = outer radius, r = inner radius, f = the tenacity of material and p the bursting pressure. In reply to the question asked in the June number, taking Mr. Cooper's figures, that is, letting r=7, and for safety letting f=6 000, we have:

$$\frac{R}{7}=\sqrt{\left\{\frac{6\,000+6\,200}{6\,000-6\,200}\right\}}$$

Rankine's formula will not work; neither will Barlow's.



THE UNIVERSAL MILLING MACHINE. SEE FIRST PAGE.

But taking Rankine's formula for their cylinders (like boiler shells, etc.), which is:

$$\frac{t}{r}=\frac{p}{f}$$

(in which t = thickness of metal), and applying it to Mr. Cooper's reply to the question in the June number, we have:

$$\frac{7.23}{7}=\frac{6\,200}{6\,000}$$

The result would be identical with that obtained by Mr. Cooper.

Mr. Cooper, it appears to me, has, in haste, used Rankine's formula for thin instead of for thick cylinders, in relation to which Rankine says: "The assumption that the tension in a hollow cylinder is uniformly distributed throughout the thickness of the shell is approximately true only when the thickness is small as compared with the radius."

Going back to the presses used in the attempt to launch the *Leviathan*, the cylinders failed, as near as we can come at it, under a pressure of 10 752 pounds per square inch. To break at this pressure, Barlow's formula would call for a thickness of 7½ inches; this is what they were. Rankine's formula would call for a thickness of 5 inches and Cooper's a thickness of only 3 inches.

After going to a thickness of, say, 6 inches (cast iron) I should certainly use steel, as suggested by Mr. Cooper. But from what I have seen and read of thick cylinders subjected to high pressures I should use the formula:

$$T=\frac{R\times P}{S-P}=$$

which, by substituting Mr. Cooper's values, becomes:

$$T=\frac{7\times 6\,200}{18\,000-6\,200}=3.7$$

inches thickness of metal. Mr. Cooper has it 2.41 inches. Even before doing this I should, if possible, find out something of the experience of others in the use of steel cylinders for high pressures, or if I had a considerable number to make, should experiment by bursting at least one.

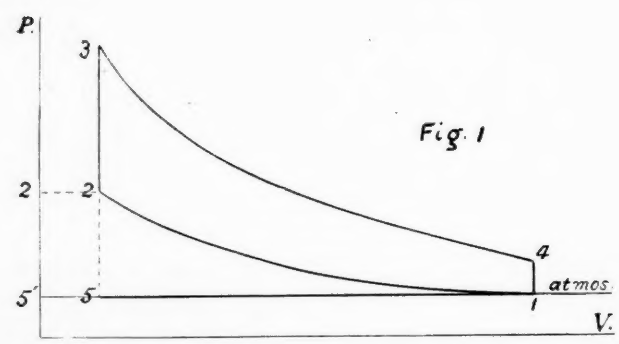
It should be noted, to avoid possible confusion, that in the foregoing formula, which is quoted from Barlow, R instead of r equals inside radius.

* * *

THE GAS ENGINE.—2.

George Richmond.

The indicator is an instrument so well understood that it is not necessary to describe it. For furnishing an autographic record of the changes of volume and pressures within the cylinder and consequently the work done it is an admirable contrivance. Knowing before hand precisely the changes we wish to produce for the four stroke cycle of the gas engine, we can construct the diagram representing them. Such a diagram is that represented in Fig. 1. Commencing with the compression at the point marked 1 we have:



First Stroke.—5 to 1, during which the explosive mixture is drawn into the cylinder through the open suction valve or valves.

Second Stroke.—Compression along line 1–2. The final volume is known, since it is that of the clearance space. The compression is accompanied by a generation of heat and the final pressure can be calculated when the disposition of this heat is known. The usual preliminary assumption is that the heat remains in the air and the curve 1–2 is then called the adiabatic.

At the point 2 the explosion or ignition of the mixture takes place, in consequence of which the pressure suddenly rises from 2 to 3. This pressure can also be calculated for a given mixture. While it is true that the gases resulting from the combination brought about by ignition are different from those originally enclosed within the clearance space, their volume at the same temperature and pressure would, if anything, be a little less. The increase of pressure, therefore, is due entirely to the heating of the gases. The amount of heat furnished by the combination of the mixed gases determine the pressure at 3. The fact that the pressure thus determined differs very materially from that which actually obtains in the gas engine, has a very important bearing on its economy and has given rise to much speculation and investigation. All are agreed that the deficiency in pressure in the actual gas engine is due to the fact that the combination is not completed instantaneously but continues during the next stroke of the piston. The reason for this "Nachbrennen," as the German writers call it, is a point on which authorities do not agree.

Third Stroke.—Expansion of the heated gases from 3 to 4. This curve usually approximates the adiabatic, but is liable to differ from it very much on account of the continued combustion above referred to. At the point 4 the exhaust valve is opened and

the pressure falls immediately to 1, namely, atmospheric pressure.

FOURTH STROKE.—1 to 5 driving out the products of combustion through the open exhaust valve. At 5 the exhaust valve is closed, leaving a volume of burned products in the cylinder represented by 5. 5^1.

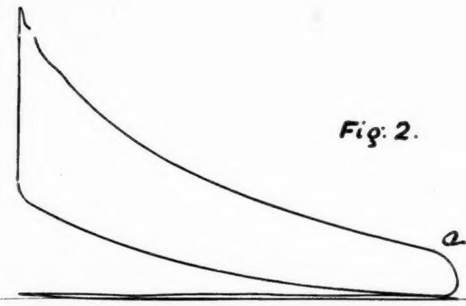
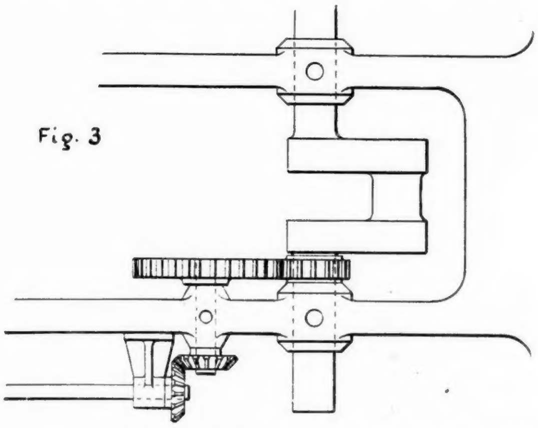


Fig. 2.

The cycle is now complete and the cylinder is ready to draw in a fresh supply of the explosive mixture, compress and explode it and reject the burned products. It will be seen that the suction and exhaust valves are each open during one stroke out of four, they cannot, therefore, be actuated directly from the crank-shaft, for any motion derived from it will be repeated every revolution, that is, every two strokes. A number of solutions will be mentioned below, the simplest being the introduction of a lay-shaft driven at half the speed of the crank-shaft. Every motion de-

Fig. 3



rived from this lay-shaft will be repeated every four strokes or two revolutions. The required movement of the valve, namely, quick opening and closing, with an interval of rest between the two, is best effected by means of a cam.

In designing this cam care must be taken not to impart too violent a motion to the transmission parts or a destructive hammering will result. The surface should be ground with an emery wheel of the same diameter as the roller and swinging on an arm of the same length as the lever carrying it. The dummy should be laid out so that the velocity of the valve and lever become zero at the seating of the valve, and at its highest lift the acceleration changing sign of course between the two extreme positions of the valve.

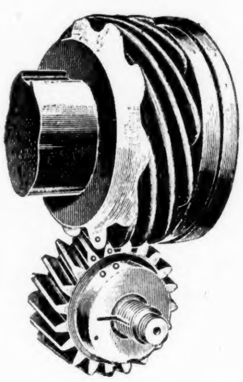


FIG. 4.

If these conditions be observed, the movement will be smooth and none of the work will be expended in jarring the moving parts. The diagram obtained from the cylinder of a gas engine differs, of course, from the ideal diagram of Fig. 1. Fig. 2 is a tracing of an actual diagram. The suction line is a little below the atmospheric and the exhaust line a little above the same. The degree to which this is observable measures the choking of the valve passages or pipes leading to them. The rounding of the curve at 4 indicates the gradual opening of the exhaust valve, commencing at the point marked *a*. The slide valve need not be considered as it has practically been superseded by the poppet valve.

When a rotating valve is used, it can be operated by gearing it to the crank-shaft by means of a chain passing over sprocket wheels having a ratio two to one. The two to one motion of the lay-shaft may be obtained by spur gear as in some vertical engines by bevel gear, or by a combination of both as shown in Fig. 3. The most used mechanism is the spiral gear shown in Fig. 4. Whatever form of gearing is used it should be marked so that the lay-shaft can be removed and replaced without disturbing the position of the cams in relation to the crank-shaft.

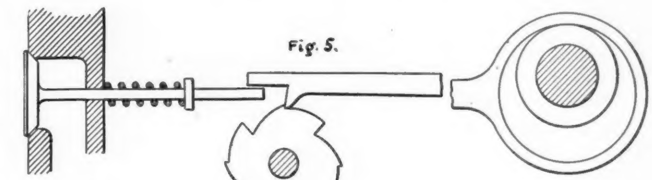


Fig. 5.

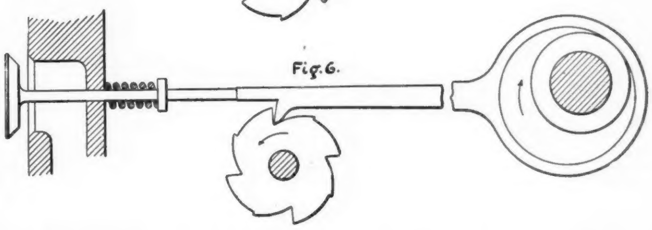


Fig. 6.

A great many ingenious devices have been designed for the purpose of avoiding the gearing and the lay-shaft. It may be observed that the suction valve may be automatic, so that only the exhaust valve is necessarily operated by mechanism. One of the simplest of these is shown in Figs. 5 and 6. A rod operated by an eccentric on the crank-shaft actuates a ratchet wheel, in which a high tooth alternates with a low tooth. When the rod falls into a low tooth it is in line with the exhaust valve and pushes it from its seat (Fig. 6). On the next revolution of the engine the rod rides on a high tooth and passes over the valve stem (Fig. 5). This is Robinson's arrangement.

At the proper moment for opening the exhaust valve the cylinder is filled with waste gases under considerable pressure. Advantage has been taken of this fact by a number of inventors and the pressure utilized to operate the exhaust value.

* * *

SUGGESTIONS ABOUT MILLING CUTTERS.

The Brown & Sharpe Manufacturing Co., of Providence, R. I., have issued a little pamphlet containing practical suggestions about milling cutters, which they modestly call: "Some things that we all know, but do not always keep in mind."

Cutters should be kept sharp. As soon as there is any appearance of dullness, pass them once or twice in front of an emery wheel. This, in the long run, will save time in sharpening, will prolong the life of the cutters, and will enable them to do their best and most rapid work.

Plenty of lubricant should be used in milling wrought iron and steel. Lard oil is generally the best, but in some cases the following soda water mixture will answer very well:

One-quarter pound sal soda.
One-half pint lard oil.
One-half pint soft soap.
Water enough to make ten gallons.
Boil one-half hour.

A cutter of small diameter, other things being equal, is better than one of large diameter. It also costs less.

Formed cutters are usually the most economical when duplicate pieces are required. They last a very long time, and all pieces cut by them are practically interchangeable.

When stock cutters or combinations of stock cutters can be made to answer the purpose, it is usually better to order these than to have special cutters made.

In selecting a cutter, except for finishing cuts, it is usually best to err on the side of having too few rather than too many teeth.

The tendency in everything, except finishing cuts, is toward coarser speeds and relatively slower feeds.

To do its best work the cutter must be used in a powerful and rigid machine.

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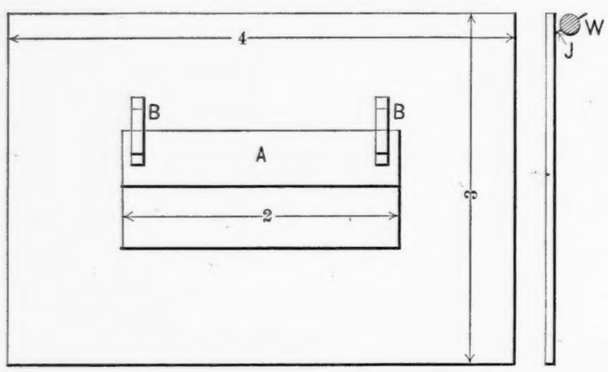
READERS of MACHINERY who wish to bind Volume II. can obtain a complete index free by sending a postal card to this office. These will be mailed with the September papers.

KEEPING BLACKSMITHS COOL.

One of the problems in the forging shop is in keeping the men cool enough to be able to work effectively, if at all. The heat from the ordinary coal furnace is bad enough in winter but becomes almost unbearable in summer, and reduces the efficiency of the plant to a considerable degree.

One of the solutions of this problem as adopted by Messrs. Wyman & Gordon, of Worcester, Mass., consists in having what is known as a "water front" to each furnace. This is made of a piece of boiler iron, quarter inch for the small furnaces, three-eighths for the larger ones, arranged as shown in sketch with this. The plates are suspended in front of furnace and are about 3 x 4 feet for small furnaces with an opening cut in the center as shown. In this opening is hinged a flap or swinging door A, on



on hinges B B, which nominally hangs down and about half covers the opening, but can be readily lifted to give more room through the plate for fixing the fire. Just in front of this, at the top, as shown by the end view at right hand, is a water pipe with numerous jets directed against the plate, keeping it covered with a sheet of water and effectually keeping it cool, which makes a splendid shield for the place. Below the plate is a concrete trough or gutter, which carries the surplus back to tanks to be used over again.

One would think that the water might add to the discomfort by being formed into steam on the plates, and if the supply was scanty, this would probably be the case. As it is, there is enough water used to prevent this. There also is another advantage to this method. It keeps the outer end of the stock cool enough to handle and is of considerable help in that way.

* * *

ABOUT CONDENSERS.

Wm. O. Webber.

The subject of condensers is one which might be extended almost indefinitely, there are so many types and they all require such different treatment and care. The duplex-pump-injector condenser is a type steadily growing in favor, is very reliable and one which ordinarily gives but little trouble. The best ones of this type have the injector cone placed vertically above the water end of the pump, which is of the packed piston type. In ordinary working, these pumps work with a steady movement until nearly at the end of the stroke, and then complete the travel with a trembling motion. If they lose their injection water the pump immediately gets both plungers about mid-stroke, and then "teters" there with the exhaust steam from the engine blowing right through the valves of the water end; it is practically almost impossible for a condenser with this type of pump, properly constructed, to flood the cylinders of an engine, as they should always be so placed as to lift the injection water up to themselves; and this type of condenser pump also has the advantage of being able to lift the condensed water, etc., up above itself again, so as to be used for other purposes. There are also a number of types now of compound vertical injector condensers built on the same general principle, in which the pump action is either duplex or quadruplex, which give a very steady vacuum and at the same time take up very little room horizontally, so that they are particularly well adapted to electric light and power stations, or on shipboard.

A number of belt driven vertical condensers are also on the market which do very good work, but personally I prefer those with direct steam action independently of the main engine, as by this means the vacuum can be started and maintained before the main engine is started, and you can have the satisfaction of knowing that this part of your apparatus is all right and in good working order, and probably intends to remain so. Almost all accidents to condensing engines happen when the engine is first started, or within the first ten minutes thereafter. Another reason why I prefer this type of condenser is because you can control its capacity to exactly suit the work being done by your main engine, which of course varies considerably in all land practice, with perhaps the exception of large cotton mills; and again the conditions of the atmosphere also largely affect the working and requirements of condensing apparatus.

There are a number of types of syphon condensers, to be used where a head of water is to be had, which sometimes work very well indeed, but often seem to be possessed of the "Evil One" himself. I have "sat up nights" with two or three of this type, and "don't want any more in mine." I think the greatest trouble with them has always been leaves, grass or sticks, and sometimes ice getting into the injector nozzle, and so breaking the suction.

Surface condensers are all right in their way, but are expensive, liable to give out suddenly, and unless placed much below level of engine cylinders are positively dangerous and never should be installed. The general cause of this type of condenser giving out is that they have not properly provided for the expansion and contraction of the tubes, which invariably should be securely held at one end and allowed to slip at the other, the tubes should always be of brass, and I suppose owing to these two requirements most engine makers make them too small for the maximum work of the engine to which they are attached. At one place where I had command, but where the power plant had been established before my advent, we used to have to couple on a length of hose to a hydrant and play on the condenser for half an hour every Monday morning, until the machinery, etc., had got limbered up and the engine was down to its normal load, before we felt safe to let her "go ahead full speed."

My objection to the belt-driven condenser is about the same as above, and is also supplemented by the inconvenient trick the belt has of coming off if anything is the matter anywhere around the plant.

* * *

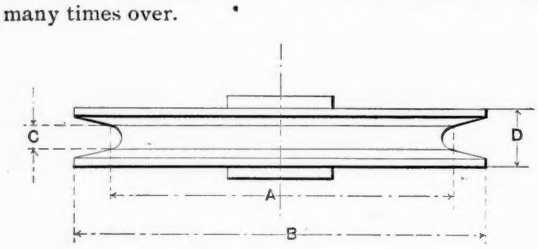
SAVING TIME IN THE DRAWING-ROOM.

E. R. Plaisted.

The greatest labor saving contrivance I have in the drawing-room is a 5 x 8 inch record book of about 300 pages, which I will describe briefly. The letters in the blue prints indicate the principal dimensions of the casting shown and the table below gives their values. The first division being reserved for the number of the pattern and the last for any details not covered by the letters.

There are pages giving floor space, speed, pulley, belt and HP. required for all our standard machines; also complete lists of spur, bevel, mortise, angle and worm gears, with racks and worms.

This little book saves many steps and many chances of error when the castings to be measured are in a dark cellar or storehouse, and while it takes time and care to make, soon pays for itself many times over.



WIRE ROPE SHEAVES.

Pattern No.	A Inch.	B Inch.	C Inch.	D Inch.	Remarks.
2187	18	22	1¼	2¼	
2188	20	25	1¼	2½	Idler.
2176	24	29	2	4½	
2190	26	30½	¾	2	
322	30	2	⅝	1⅛	V groove.
2143	16	17½	⅞	1½	Solid web center.
2077	25	30	2	4½	
2104	60	65	2½	5	

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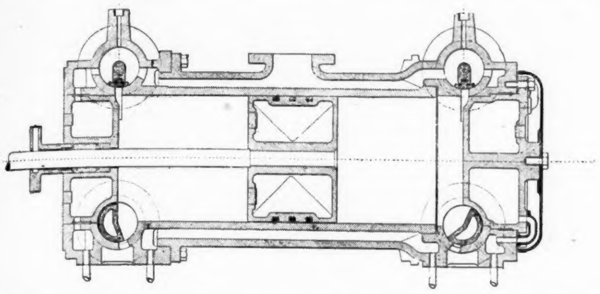
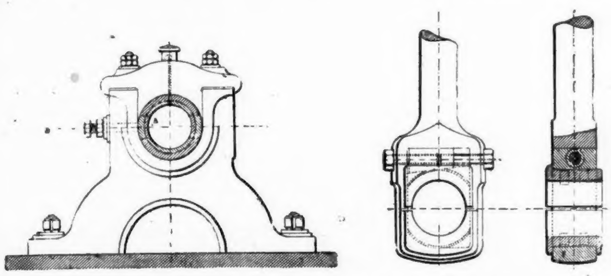
Mr. Wm. Gowie, formerly with the Camden Iron Works, Camden, N. J., has taken charge of the tool department of the L. S. Starrett Co., Athol, Mass.

FOREIGN ENGINE DETAILS AGAIN.

Some of the engine details which were shown on page 310 in the June issue and credited to the catalog of H. Bollinckx, of Brussels, Belgium, were not the practice of that firm but were shown as horrible examples of "how not to do it." We suppose we might manage to crawl out of the scrape by making some sort



of a slippery explanation, but we won't. It was simply because we couldn't read French and, seeing in the catalog illustrations which are not usual here, thought they would be interesting, and supposed them to be the practice of H. Bollinckx. It's all our mistake, no printer's devil or any one else to blame this time. Messrs. Bollinckx disclaim the jacketed cylinder shown in Fig. 1 and pin their faith to the construction shown herewith.



They also disapprove of the pillow block adjustment shown in Fig. 4 on that page as well as the form of connecting rod end in Fig. 3, prefering the ones shown with this, and using them in their practice. We believe the others were all right, and while not attempting to hide the error, we still think the designs shown are interesting as giving different ideas on the subject.

* * *

MACHINE DESIGN.

JUNIOR.

In presenting to the readers of this journal the following papers on the subject of Machine Design, it is the purpose of the writer to relate some of his own experience and ideas, in the hope that they may prove of value to those who are connected with the mechanic arts. Some of the features of the papers have been written upon time and again; and as each succeeding week we see or hear something new and of importance, those who wish to keep up with the procession, be it either in mechanical or mercantile life, realize they must read papers and books pertaining to their pursuits, and as it is from others that most of our knowledge is gained, I trust that this article may prove of some benefit.

In making the original construction drawings for machines, the writer has sometimes found it very convenient to lay out to scale in a general way the principal parts, and then to work out constructions of some of the more complicated parts separately. By so doing, the parts containing feed mechanism, etc., can be more thoroughly considered than when an attempt is made to lay them all out on the main construction sheets. Some designers have the faculty of being able to crowd enough lines on a drawing to make an ordinary mechanic sick at heart when he has to analyze the same. The drawing may be considered as only a line memorandum of the designer's ideas, and consequently should be as clear and distinct as possible, so as to leave no doubt as to what it is intended to represent.

The practice in different shops varies greatly as to how drawings should be figured. Some contend that all the dimensions should be given, and the finished parts marked by an additional parallel line. Others use letters to denote finished parts or use the word "finish." There are those who take the blue prints and follow around the finished parts with a red lead pencil, but to me that always looked like an extra lot of work, especially for duplicate machines. The rule adopted in a certain well-known works is that no figures are to be given except where finish is required. The writer's preference is for the latter method, except in the case of very small scale drawings, which, although never desirable, are sometimes essential.

In the exception above noted, all the dimensions are given; those intended for the pattern maker being denoted by small figures, and those for use by the machinist in larger figures with the letter "F" added to them. This method has proven satisfactory after a test of some years. I believe that an impression prevails that it is not good practice to leave the drawings in such shape that it will be necessary for the pattern-maker to measure them, but I think that it is choosing the less of two evils when we allow him to do so.

If possible, the drafting room and pattern shop should be located as close to each other as convenient; as there are so many questions continually arising which make it necessary for the heads of these departments to confer with each other.

It is the practice of some machine builders to have assembly drawings made which contain all the essential parts of the machine, and the principal dimensions given, the purpose of such drawings being to serve in both the machine and pattern shops. Others have drawings made where each piece is shown in detail, and generally the latter would appear the most convenient form to use. In a certain shop it was formerly the custom, when a new machine was to be built, to have an outline drawing of it made, and then the head of the firm would spend a great deal of his time in the pattern shop, having the main patterns shaped up to suit his own ideas, and, for all the author knows, that practice prevails in some shops yet; but in the one referred to above they have long since discarded it, and now have a good drawing room system.

Mr. Blank used to say that these new fangled draftsmen made him tired, spending most of their time making dotted lines in place of going over to the pattern shop once in a while to see what they were doing there.

A thorough drawing room system is an essential feature in most manufacturing establishments, but both that and the pattern shops are often looked upon as unproductive departments, and are neglected both in equipment and the class of help employed there, on account of such views. It may be possible for some men to construct a machine without adequate drawings, but it generally causes a commotion and a loss of time and money when it becomes necessary to duplicate the machine built in that way. The details of a machine are sometimes changed after the drawings have been sent to the construction departments, often because the men in charge see a possibility of cheapening the cost of the article, and such changes, unless immediately reported to the drafting room, will be likely to cause trouble at some future time.

A knowledge of the strength of materials used in construction is one of the necessary qualifications an engineer must possess. In some branches of engineering there is very little data published from which he can obtain information as to the power required to perform certain work, and as a consequence he must know what others have done in the same line of work on which he is engaged, in order that he can design machinery which will compare favorably with previous machines as regards strength and producing capacity. The steam engine has engaged the attention of many investigators, and as a consequence we now have much valuable data on that subject; but there are not, to the author's knowledge, many tests compiled showing the power required to reduce the metals, by planing, turning, or drilling and milling, and also for plate bending machines. It would appear as if such data would be useful to machinists in general.

The question of pattern storage room, in a large works, becomes a matter of great importance, as it is necessary to provide buildings that will be convenient to place and remove the patterns after they have been returned from the foundry. In a shop where a great number of special machines are built, there are of necessity many patterns made which will never be used but once. These are generally kept to fill repair orders, but they take up room in the pattern house the same as patterns for standard machines. While one is often tempted to destroy some of the old patterns, he is restrained by the thought that they may be useful some day, and as repairs are wanted without delay, these must be kept in a reasonably accessible place. In some shops there does not seem to be much attention paid to drawing records or pattern storage, the idea being apparently that there will

always be some one around the place to find things when they are wanted. Of course, it is a good practice to retain men who are thoroughly acquainted with all the details of their departments, but as we have no lease on life, or certainty that those men will always be with us, I believe that records should be kept in such a way as to in a measure prevent confusion when valuable men see fit to leave the service of a firm.

The commercial side of the business should always be taken into consideration when machines are being designed, as in this age of sharp competition it is essential to make each piece or detail as simple as possible and of just the right proportion. Some designers will work out complicated devices, designed with a view of showing up some pretty motion, or fancy gear train, rather than consider its commercial possibilities. When castings are to be designed, careful consideration is often necessary that the important item of simplicity is well taken care of. Sometimes castings are made with lugs, brackets, etc., cast on them, that cost more money in the foundry than they would if they were bolted on to the main casting. Large masses of metal are to be avoided where they are liable to cause cracking of the casting during the cooling process. There is also danger that distortion of the casting may occur when bad proportions exist between the heavy and light sections, due to the fact that the light section will cool quicker than the heavy one, and it will have taken its permanent form.

The younger generation of mechanical men can review the work of engineers of the past, and see some of the changes that have taken place in both the appearance and strength of the machinery up to the present time. Take for instance the housings of planers and boring mills, which a few years ago were made with a web section, but now are changed by many of the builders to the double web form, adding at the same time strength to the castings, and a form which is pleasing to the eye. Punching and shearing machinery designs have also been changed to the box section, and we do not see the solid bodies with heavy ribs now, as in former years. That the sections which require cores are more expensive than those that can be made without them is true in general, but the added beauty and possibility of more properly distributing the metal, more than counterbalances the increase in cost produced by their use. We seldom see now the old cross section form of arms in fly-wheels or gears, but in their place is the more massive looking oval section. In machine tool construction the oval form is used by some builders where ever it is possible to do so for levers overhanging bearings and gear arms.

The individual preference of the draftsman having charge of the design of a machine, must often be cast aside in order to satisfy the chief of the department, who may have other views as to the best form and proportions of parts of the machine. Antagonistic views leading to arguments on subjects of that kind, where the ideas of the draftsman and chief of the department are different, only result in ill feeling and generally do but little good. The supposition is, that a man who is at the head of a department is placed there on account of his superior qualifications, and it has always been the writer's policy to respect the instructions of those under whom he happened to be employed, regardless of personal opinions. I have read of chief draftsmen who changed details just for the reason that they had it in their power to do so, but as the writer has never been employed by any such class of men, he thinks that if there are many they surely put themselves to a great deal of trouble for nothing, and also that they could do something more to their credit if they would find other work to occupy their time.

There will never cease to be a demand for new inventions or improvements on old devices and methods of manufacture.

The designer of a machine must always take into consideration the facilities of the shop for producing the work. The equipment in many small shops is not on the same scale that it is in the larger ones, and a man who has had his training with a concern where all the facilities are at hand for doing almost any class of work, will need to inquire into the matter of shop equipment when he undertakes to design a machine for a shop of limited producing capacity.

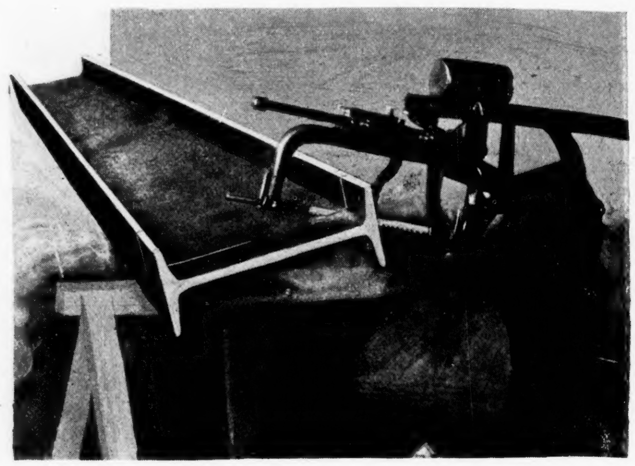
Good judgment as to the best form for parts of machines, often has much to do with success or failure in a financial way, when contracts are made to build special machines. Where a standard line of goods is made, the price of each piece can generally be found within reasonable limits; but where special machines are to be built, the kind of materials, the kind of machined work, and the weight of parts all have to be considered. Practice at estimating costs and a familiarity with the costs of other machines of the same class (if such had been in existence) and careful consideration as to the best methods of finishing the parts of the machine, are some of the things of value to those whose duty it is to make estimates.

Thorough harmony between different departments is essential to success. Where jealousy exists it will be sure to manifest itself, causing unnecessary annoyance both to the proprietors and to the heads of departments.

* * *

CUTTING OFF A LARGE "I" BEAM IN A POWER HACK SAW.

A good example of the adaptation of tools to work beyond their nominal limits is shown in the cut. The Meriden Machine Tool Co. had an "odd job" cutting off some large "I" beams, and having no heavy tools adapted to such work, were driven into using the saw, one of the Miller's Falls Co. make. The beams were



first sawed half through on one side and then turned over and sawed through to meet the first cut, and the second cut "lined up" with the first to within $\frac{1}{16}$ inch in the worst case, and came practically perfect in the best case, so that the beams were easily broken, and made a practically perfect job for the class of work involved.

* * *

NOTES BY A ROVING CONTRIBUTOR.—I.

GRINDSTONES—TOOLS TO TURN THEM OFF—SHANK STONES—ROLLING ABRASION—A PONDEROUS LATHE—PLANING PAVING STONES—OIL AND WATER—GRANITE MACHINE BEARINGS—OTHER THINGS.

A roving commission, such as here accorded, may be a compliment and it may not. That depends on whether based on confidence or as an expedient to get one out of the way—banish him, so to speak. There is in the present case surmise of the latter, in the fact that these notes are to be read by the 'Professor," rather then by the editor and some other folk, before "going in;" which let pass, in so far as the reader is after all the tribune of final appeal.

The Professor, who has been apprised of his and my function in the case, writes:

"Keep on the alert for scientific facts, and also inferences. Useful things develop themselves; besides, are vulgar (in the Latin sense of the term). Remember, too, that a hint is as good as a page; is indeed better in most cases—saves paper, ink and time, both yours and mine. Do not write lightly of serious things, and send affidavits with all questionable statements of fact, otherwise your copy stops here and the editor is left in peace. Now go on; go to "THE PROFESSOR."

I propose to "stump" the Professor in this first installment of notes—on grindstones. I do not think he ever saw one, or would know it from a cart-wheel. The suggestion came from seeing a man try to turn off a grindstone with an old file. I had seen that before, many times. He thought as would the Professor no doubt, that the bevel-pointed tool would cut like an edge on the principle of a cleaving wedge, and shave off the lumps as a carpenter planes a board.

It is not easy to determine just what takes place in turning off

a grindstone; but one thing is tolerably certain: the abrading action is due to lodged particles of the stone, otherwise why does the operation go on contrary to all rules for turning metal or wood? For example, the softer the tool the longer it endures; the tools work best in a dragging position and better when flexible, all of which seems a paradox.

If one goes to a grindstone factory, at Berea, Ohio, for example, he will find the turning tools to be rods of soft steel about half an inch in diameter, square or round, drawn down at the ends, three to five feet long. Either this or a piece of common gas pipe, which after all is the best tool for the purpose ever discovered. These tools "hang" and tear off the material, while a stiff, hard one would slide and do no good.

There are three ways of cutting stone. One by arresting on the tool a pile or coat of sand, that becomes the abrading agent; one by rolling abrasion produced by pressure and pulverizing, and a third by wedging off spawls. There is also actual cutting or cleaving, by means of carbons, or diamonds, which neither I nor anyone else understands, beyond the fact, and the fact is expensive.

Among various expedients (and there have been many) for cutting stone, the most effective is the "rolling wedge," that pushes off or spawls the material. Gen. B. C. Tilghman, of Philadelphia, who has perhaps given more study to processes for reducing very hard material than any one now living, when studying the sand-blast problem, made a journey to Aberdeen, in Scotland, to witness the turning of granite columns, and found there just what he expected, the rolling wedge, impelled and held by lathes, of power and dimensions that would put a modern ordnance tool to shame. The owner informed the General that when the lathe was made, the firm bought up all the cast iron around their district and had it run into the frame. The tools were rolling discs, mounted like a lathe tool on a slide rest, and set oblique to the axis of the piece, the same as a well-known grindstone turning device in this country; but the scheme was not new. Few things are new, except in spots.

More than thirty, perhaps forty, years ago this method of cutting stone was invented and patented by a Mr. Young, of New York City, and no doubt invented by many people besides; one of them in Philadelphia about 1877, who nearly spoiled a good shaping machine, besides spending a good deal of money in planing paving stones with a rolling disc. He did not aspire to a planed-off street surface, but selected these Philadelphia cobbles as the hardest stone available. They were plenty, too, in that city, where they are laid with much care, the contractors being furnished with a common barrel hoop and instructed that no cobble should be laid that would not pass through this gauge.

There is more in the grindstone problem than turning them off, and some things that I must leave to the Professor. For example, the makers of handled implements in England use what they call shank stones to trim off the shanks of tools, such as chisels. These shanks, as may be noticed, are ground crosswise, or to be more exact, "transversely," and are ground dry. Deacon Barton, the old tool-maker at Rochester. N. Y., imported these stones to grind shanks with, and I have seen it done, without glazing.

Here is a controversion of all rules in grinding. Hard stones should glaze sooner than soft ones, and all stones if run dry. In fact the cutting capacity of a grindstone is inversely as its hardness, or to state it in another way, the amount worn from a stone, in rapid grinding, is as the amount of metal displaced by the stone. I mean in grinding with water.

The fact is that we do not know much of abrasion. It smacks too much of the useful arts to command the attention of scientific men. The moraines of a glacier are proper subject matter, but a grindstone—bah!

Rub a piece of steel on a fine stone, the result is a gloss of metal and heat, but no cutting. Pour on some oil, or lubricate the surfaces, then abrasion begins. Substitute a piece of metal for the stone and all is changed. Abrasion takes place as soon as the surfaces are dry, and ceases with the oil. This is the law of all metallic bearings, as every one knows. But once more. In Sweden, where the natural materials of construction are wood and granite, the old millwrights mounted the gudgeons of their water-wheels on "granite bearings," and they did well. I have seen it. I nearly broke my neck in prying up an old wheel shaft, one time, to see the surface of the matrix beneath. It was as smooth as glass, hard, and *metal*. The granite rubbed off enough of the metal to form a lining, which became embedded in the stone and formed a perfect bearing.

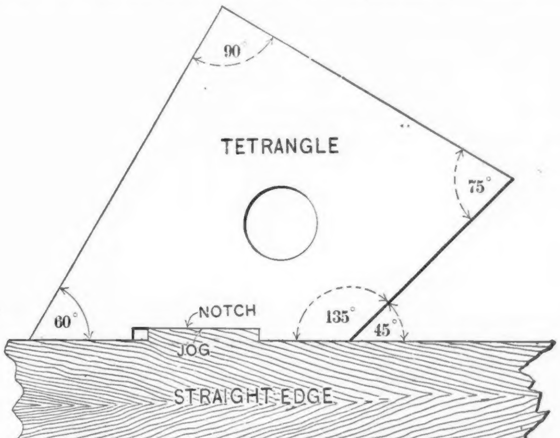
We are not done with this matter yet, and I fear will not be. Put some oil or grease on an emery-wheel and see how quick it will go out of business. Use water and note the difference.

* * *

"TET" ANGLE VS. "PET" ANGLE.

ROBERT GRIMSHAW.

I used a tetrangle or "tet" angle (such as is shown on page 291 of your June issue), in 1866, when with Reaney, Son & Archbold, Chester, Pa., the Delaware River Iron Ship and Engine Building Works, commonly known as "Roach's." I got the idea either from my right hand neighbor in the drawing-room, the chief draftsman, Mr. Robinson (formerly with Miller & Allen, of Chester), or from my left hand neighbor, Henry Larkin. The only difference was that after getting tired of hatching stuffing-boxes and the like, representing sections of concentric pieces, I cut a rectangular notch in the edge of mine (as here shown) and used it with a straight piece having a projection rather shorter than the notch, so that by sliding first one piece and then the other hatching could be done with absolutely regular spacing. Later I used instead of a notch two thin pieces of wood on the straight-edge, fastened on temporarily with thumb-tacks; this did not disfigure the "tet." The only disadvantage of the thing, either with or without the cross-hatching rig, is that it is "tippy-toppy" rather than "tip-top." We used the "tet," such as I show, in Fig. 5 page 303, for drawing screw-threads and also for hatching; having a number of them to represent various pitches, etc. In



this latter particular the appearance of a drawing is much enhanced by having several distinct but definite pitches in drawing screws "conventionally."

In those days there was a great deal of time wasted in drawing every rivet in every seam; and not only that, indicating by two lines at an obtuse angle, inside the circle representing the head, which was the "second head" as distinguished from the one which comes on the rivet as bought. Border lines and elaborately made titles in block and "pearl" letters were the correct thing on all general views, and many thousand dollars were put uselessly in that sort of thing. The fact that $20.00 worth of time on a drawing representing a $20,000 or even a $100,000 boat is but a very small percentage of the price of the article does not detract from the fact that it is $20.00 very uselessly spent, and the drawings are better without borders or fancy lettering. I doubt if any government or any private citizen was ever induced to give an order by the extra finish on the drawings; and am sure that the thousands of rivet heads on the drawings for tank-sheets hinder rather than help the punchers.

In reference to the draftsman's tack hammer on page 296; for the same purpose give me a pocket knife. Press the tacks in with the end of the handle; draw them with the blade.

Dresden, Germany.

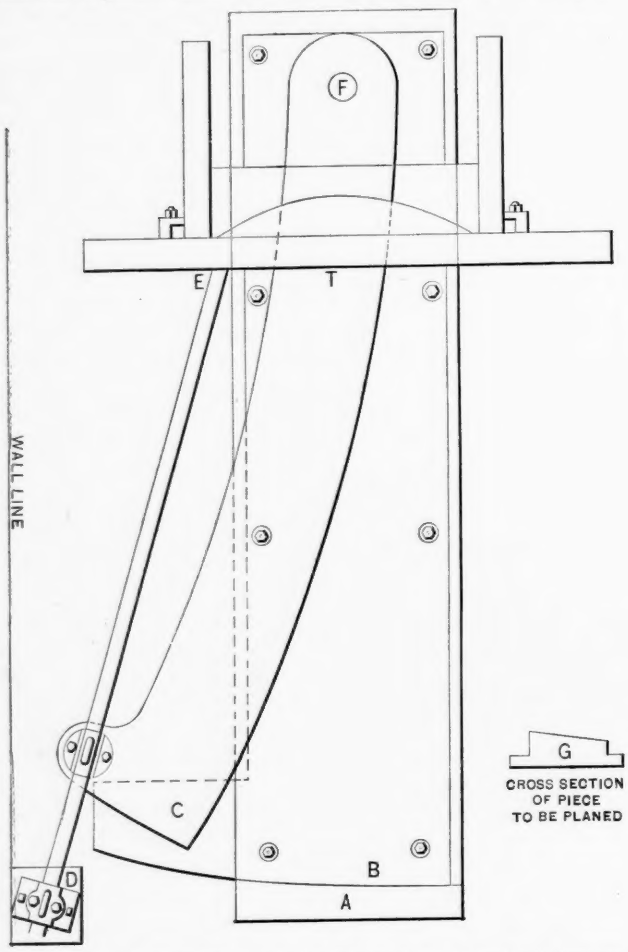
* * *

MR. GEORGE L. GILLON, Treasurer of the Watson-Stillman Company, says that the example we quoted in July of the returns from an advertisement seven years after its insertion is not by any means an extreme case, as within a week a customer came into their office with a slip cut from one of their catalogues published seventeen years ago. Who says he can trace all the results of his advertising?

PLANING AN ARC.

J. W. McCurdy.

I enclose a rough sketch of a device we used some weeks since to plane a set of radius plates for a swing bridge track. We knew the usual way is to have a radius rod pivoted on a fixed center to move the swinging chuck. But in this case the shop was entirely too narrow, so we devised the chuck as per sketch. A is the platen of an ordinary Gray planer. B is a plate bolted solid to planer, C is the movable chuck pivoted to B at F, S is a piece of steel shafting bolted to angle-plate on wall at D and to cross-rail of planer at E. Now it is obvious that when the platen



CROSS SECTION OF PIECE TO BE PLANED

moves back and forth the box H pivoted to C and sliding on S will cause the tool T to follow the arc of the chuck. A number of mechanics, including the Bridge Co. engineer, who saw the device before completion, said it would not do the work; but it fooled them all and did a very satisfactory job in excellent time. Since then I have got into several arguments as to what kind of a curve this device made. While all admit it was close enough to be practically correct, there was still an error, however small. We would like the benefit of your readers' opinions through the columns of your valuable paper.

* * *

TAIL STOCKS OF LATHES.

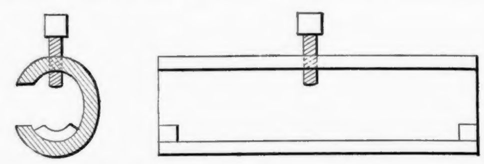
J. Richards.

In the July issue of your paper there is a drawing of a lathe sliding head, or tail stock, published as an example of drawing, but also illustrative of two more points, one mechanical, the other commercial. This tail stock, as is common in this country, does not project forward of the main face; that is, the poppet spindle has no support beyond the head. The mechanical point consists in the fact of the lack of overhang, narrows the central portion of the lathe carriage in the same degree, and as this latter is a "crowded" dimension, it is good practice to make a tail stock in this manner. The commercial point, which not one in a hundred is aware of, is that every inch omitted on the forward end of a poppet-spindle sleeve permits a like amount to be deducted from the length of the main frame. This latter is no doubt the main reason for omitting the projecting sleeve on sliding heads. The rigidity of a poppet spindle is not much affected by a reasonable overhang or projection in front, and the same amount of width added to the bridge of a carriage is a very important matter, increasing the stability of a carriage as the cube of the added width, or approximately in that degree. These cut-off poppet spindle sleeves is a common objection to American lathes, because of the effect on the carriage and also the inconvenience of bringing tools to the end of the work. The sleeves are shells should project from one to two diameters of the poppet spindles, the main frames being that much longer and carriages that much wider between the lathe heads.

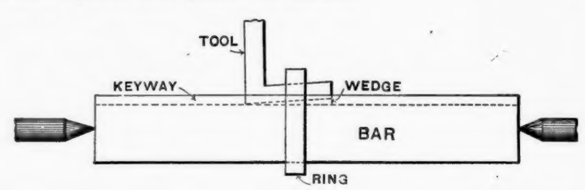
* * *

IN A SMALL MACHINE SHOP.

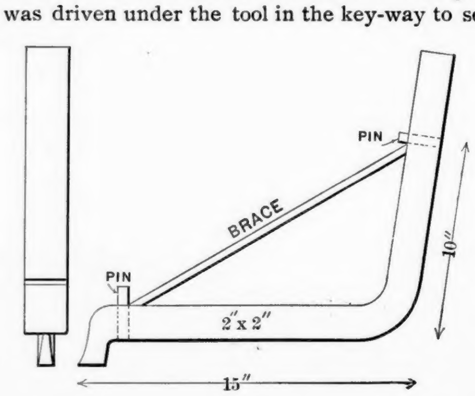
A shopmate of mine, after serving three years as handy man at the shop, was put on an old planer where there were no raising or lowering screws for the cross slide; he would always put his work on three parallels, then he would bolt the work down on the platen and set his cross slide to his work with a jack-screw and a block of wood, the fitting he did with a broken two foot rule and a plug of tobacco. He was now put on a lathe, and he always thought lathes were set parallel with the countershafts above. One day he had to turn the end of a shaft which was bent all over and twice as long as his lathe, the end of his lathe just touched the side of the office, so he started to chip a hole in the wall so his shaft would go above the clerk's desk. Boss came



along and told him to move the tail end of the lathe 2 feet over, so that the end of the shaft went out of the door into the street, the belt ran as well then as when the lathe was straight; he had three men on a long bar and he tried to straighten all over, but the short kinks always were there, so he went to the foundry scrap and picked out an old cast iron pipe two feet long, as sketch, he chipped one-third off the pipe the whole length, so he could put it over the shaft anywhere, he tapped a hole on top at center for an old set-screw, and beneath the set-screws at ends he put two inch square iron pieces, as sketch.



One day he had a large hub to bore out for a dredger a few hundred miles away, a hurry job, and the parties had sent a gauge for the bore and a sketch of two 1¾-inch keys to be cut in hub at 120° apart, the bore of the hub was 10 inches, length 36 inches. The hub was bolted on the carriage and an old shaft was put in the centers with a key-way in it, to receive right angle tools, as sketch. A loose ring was found which fitted over the tool and shaft to hold the tool to the shaft or boring bar, while a wedge was driven under the tool in the key-way to set the tool



in or out; when he was done he took the tool post of the planer and put it at the end of the hole and marked the 120° on end, then with his tool on the bar he ran the carriage back and forward four times and there were four lines in the hub, straight, the hub was cast hollow in the center. The chipping of these key-ways was slow to him, so he put the hub on the planer and bent a right angle tool, as shown, 2 x 2 inches, and put a brace to the ends, a half-inch square tool on the front. F. E. G.

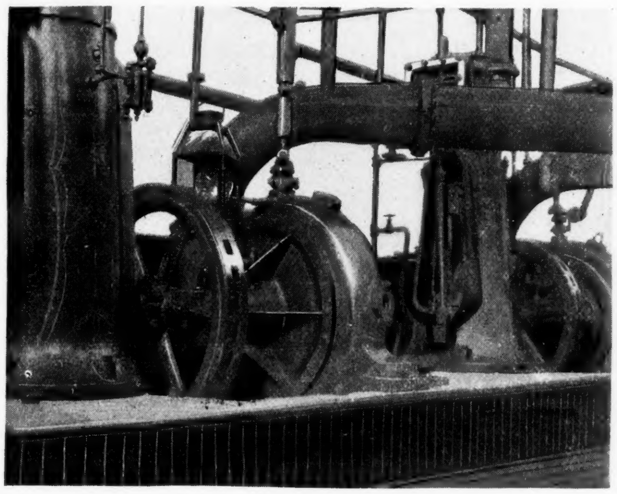
A DRY-DOCK PUMPING PLANT.

JOHN H. COOPER.

The little picture in the body of this article was taken in the power house of the centrifugal pumping plant for the dry or graving dock at League Island Navy Yard, located on the Delaware river, at Philadelphia, Pa., and represents a 12 inch centrifugal pump in duplicate, which is employed for relieving the dock of leakage water after the dock has been emptied by the two main centrifugal pumps not shown. Each of the drainage pumps is driven by its own directly connected vertical engine, and each is provided with independent suction and discharge pipes, so that either or both may be used as occasion requires.

All of these pumps are located below the ground level, so that their shaft and pump centers will not be more than 21 feet above the lowest water level permissible in the dock, for convenient working upon its floor, as the suction limit for best performance; the whole depth of the dock being about 35 feet.

For emptying the dock of its several millions of gallons of water, within the practical limits of time, say one hour, necessary to safely secure a vessel therein, there would be required an adequately proportioned pumping mechanism, capable of discharging at least 80,000 gallons of water per minute. To accomplish this result two centrifugal pumps having 42 inch diameter suction and delivery pipes are placed in this room (not shown in this picture and difficult of snap-shotting for want of space and light), their suction pipes reaching to a sump below the lowest level of the dock, and their delivery pipes and submerged discharges ways extended to the river.



The pumping head of these main pumps varies from nothing at the start to about 35 feet at the finish, and these main pumps may be stopped to give time for blocking the ship and started again whenever occasion requires. The drainage pumps shown, being used only for freeing the emptied dock of leakage, they do all their work under the extreme head named, varying only from this by fluctuations of the tide without the dock and by slight changes of water level within the same.

In practice it is found quite impossible to secure a vessel in the dock, so rapidly is the water removed by these main pumps. One pump will ordinarily do all that is required to empty the dock, and even then it will require sharp work to properly shore up the vessel to make it safe, following the water as it is removed.

On test of a similar pair of pumps to these, when the pump wheels were making 160 revolutions per minute, the discharge from both was 137,797 gallons per minute; the contract required 80,000 per minute.

These pumps were designed by the writer and built under his superintendence, at the Southwark Foundry & Machine Co., Philadelphia, Pa.

* * *

ABOUT MILLING MACHINES.

It has occurred to the writer that the machine shops for years have been using milling machines of the most ridiculous design. I mean that, instead of following out the principle of the planing machine and making the bed one and a half times the length of the carriage, the carriage of the original column and Lincoln pattern is about three times the length of the saddle, which corresponds with the length of the planer. The design is from the original universal milling machine, built for tool room work and is well adapted to that work, the same as the shaping machine, whose ram is longer than the bearing and is adapted to short planer work.

For years, the milling machine stopped at the tool room. When its possibilities began to dawn on the mechanical public, instead of trying to obtain suitable machines for the work, the old fashioned column milling machine began to grow. First, the carriage was made longer, then the saddle was increased in length and under-braced, then the head-stock was made heavier and, to support the end of the arbor, a make-shift, in the way of an over-hanging arm, was added to the machine; then the design of the machine grew and it was found that the over-hanging arm and the knee would spring away from each other. To overcome this, they were tied together with slotted rods. When the enterprising milling manufacturers undertook to introduce a milling machine that was built on the lines of a planer, they were laughed at for their pains. Superintendents claimed to advocate their designs, but when it came to buying, what did they do? Did they buy this new heavy milling machine? No! In nineteen cases out of twenty they bought one of the antique trussed column milling machines, and because they would not cut metal like wood planers, they condemned milling machines in general.

There have been a great many changes in the last few years in favor of the heavy substantial milling machines of the modern type. I do not think that all the possibilities of the milling machine have yet been thought of. I suppose that almost every foreman has been in some of the down east shops and has seen boys operating hand milling machines, where some substantial pieces of cast iron or steel are clamped in the vise and the pieces passed under the cutter with the single motion of the lever. There are many classes of work that can be done with this rapidity, as the cutter is in the work for an instant only.

If the milling machine for heavy work were designed to feed the same proportion to the size of the work, as these little hand machines are, I think you would obtain astonishing results; not nearly so astonishing as the expression on the owner's face, when some machine builder will submit a design, and especially when he quotes a price. A short time ago I was in the General Electric Co's. Works, at Lynn, and, in the Motor Gear department, I saw two Newton milling machines. These machines were for milling the halves of the split motor gears, and weighed, I should judge from looking at them, about 20 000 pounds each. They were built on the planer style, as above referred to, and were milling cast iron gears at the rate of 5½ inches per minute. These were running the cutter in the old fashioned way; *i. e.*, feeding against the cutter. This convinces me that it is the only proper way to do heavy milling, as this is the most successful fast milling that I have ever seen. I would ask the old timers to consider this work. A few years ago, a man who would put in a machine of this weight for doing narrow work would be considered crazy, They would, and probably have been, doing this work in other shops on column milling machines.

The whole success of practical milling gets down to common horse sense, but it seems as if the possibilities of rapid milling were hardly known. This is getting almost to what I above referred to in comparison with the size of the machine to the size of the work; it would be more on the proportion referred to on the small operations on the hand milling machine. As queer as it may appear, there are thousands of foremen and superintendents who cannot get the column milling machine out of their heads; even when they see the heavy machines work, they will go back to their old hobby and, if the machine they have is not heavy enough, they will get another heavier trussed machine of the column pattern. This, of course, will all come to an end in time and no one will consider buying the over-lapping carriage milling machine any more than they would consider a planer with a much shorter bed than carriage. But before this takes place lots of men will have to retire, and I think many of them will carry their antique milling machine ideas with them to their graves.

M. C.

* * *

THERE seems to be a general lack of positive knowledge concerning the amount of grate and heating surface, and rules which ignore varying conditions give strange answers to the problems solved by them. It is certain that there is a great amount of useless heating surface in many boilers in use to-day, but it is gratifying to note that this is being recognized and remedied.

TALKS ON STEAM ENGINEERING.

STEAM TABLES.

CHAS. L. HUBBARD.

If we examine a "steam table" giving the properties of saturated steam, we will find the following quantities and data given.

Before going further it will be well, perhaps, to have in mind a clear idea of what is meant by the terms "Dry," "Wet" and "Superheated" steam. "Dry steam," as the name indicates, is simply water vapor, having a temperature corresponding to the pressure under which it exists, when in the presence of water from which it was evaporated. When the steam has in suspension a greater or less quantity of water in the form of fine particles or spray, it is called "wet."

PROPERTIES OF SATURATED STEAM.

1	2	3	4	5	6	7	8	9	10
Pressure above a vacuum in pounds per square inch.	Temperature, Fahrenheit degrees.	Heat Units required to raise the water from 32° F. to temperature, T.	Internal Latent Heat.	External Latent Heat.	Latent Heat of Evaporation at press. P=I+E.	Total Heat of Evaporation above 32°=S+L.	Weight of a cubic foot of Steam in pounds.	Volume of a pound of Steam in cubic feet.	Ratio of volume of steam to volume of equal weight of water at its greatest density.
P	T	q or S	I	APu or E	r or l	H	W	v or C	V
60	292.57	262.24	830.50	78.42	908.92	1171.17	.1423	7.02	438.5
70	302.77	272.65	822.52	79.10	901.62	1174.38	.1645	6.07	379.3
80	311.86	281.95	815.41	79.69	895.10	1177.06	.1866	5.35	334.5
90	320.09	290.37	808.98	80.21	889.19	1179.56	.2085	4.79	299.4

If a quantity of water should be placed in a closed vessel, and heat applied, the water would be evaporated into steam. Suppose the temperature and pressure should be taken at the instant the last particle of water was changed into steam, and the results recorded. Now if still more heat be applied, we shall find that the temperature will rise, while the pressure remains the same. The steam is now said to be "superheated," and the difference in temperature between the first and second readings of the thermometer will indicate the degree of superheat.

The term "Dry and saturated," as used in steam tables, means simply *dry steam*. That is, it contains no water nor spray, and has no superheat.

Now let us look at the headings of the different columns and see exactly what each means.

1st. Pressure per square inch above a vacuum (or absolute pressure), symbol P. The pressure shown by the steam gauge is 14.7 pounds less than the actual pressure inside the boiler, for the pressure of the atmosphere is acting on the outside of the gauge, and the pointer indicates only pressure *above atmosphere;* so 14.7 pounds must be added to the gauge reading to get the absolute pressure in the boiler. All comparisons of pressure in which ratios occur, should be made in absolute readings.

2d. Temperatures in degrees Fahrenheit, symbol T. Dry and saturated steam under a given pressure always has the same temperature. The temperature corresponding to different pressures has been accurately determined and recorded, so by knowing the pressure, we can find the corresponding temperature at once, in a "steam table," or the temperature being given, the pressure is found in the same manner. The quantities occuring in columns 3 to 7 inclusive are best explained by the following illustration. Let A A (Fig. 1) be a cylinder, and for simplicity consider its walls impervious to heat; that is, not capable of absorbing heat. Let W be a heavy frictionless piston sliding in the cylinder. Suppose the weight of this piston to be 6 525.2 pounds. If its area is 1 square foot (144 square inches) it will require a total force of 8 640 pounds, or 60 pounds per square inch to raise it against atmospheric pressure ($144 \times 14.7 = 2114.8$, = downward pressure due to atmosphere, and $6\,525.2 + 2\,114.8 = 8\,640$, = total downward pressure, and $8\,640 \div 144 = 60$ pounds per square inch to raise the piston). Let a pound of water at a temperature of 32° Fahr. be placed beneath the piston, and a thermometer attached as shown. Now let us apply heat to the bottom of the cylinder and see what happens. First there will be a gradual rise of the mercury in the thermometer; this will continue till it registers a temperature of 292.57° Fahr., at which point it will remain stationary. The piston now begins to rise, showing that evaporation has begun. This goes on till it has reached a height of 7.024 feet above the bottom of the cylinder. If still more heat is applied, the action is again reversed and the piston remains stationary while the temperature rises. The explantion of this is as follows: At the start there is a pound of water under a pressure of 60 pounds per square inch The evaporation or boiling point corresponding to this pressure is 292.57° Fahr. When the water reaches this temperature, evaporation begins and the temperature remains constant. The steam as it is formed requires more room than the water from which it was evaporated, and the piston is raised to give the necessary space. Evaporation continues until the water is all changed into steam. The piston by this time has risen to a height of 7.029 feet, giving a space beneath it of 7.029 cubic feet, which is the volume of 1 pound of steam under the given conditions of temperature and pressure. Any further heat which may be added, only goes to increase the temperature of the steam (superheat it) without increasing the pressure.

A British thermal unit (B. T. U.), or heat unit, is the amount

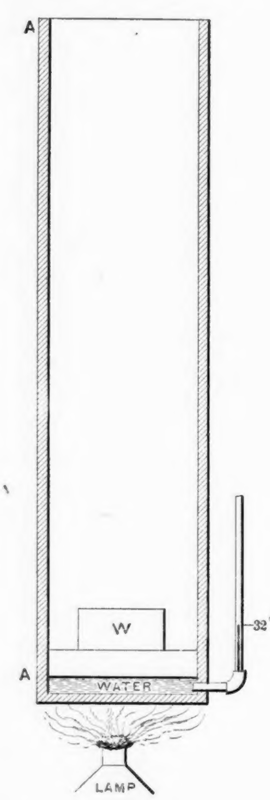


Fig. 1

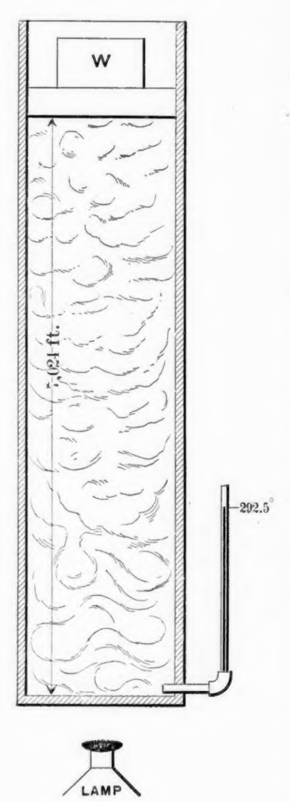


Fig. 2

of heat required to raise 1 pound of pure water 1° Fahr., when at its greatest density, or at about 39° Fahr.

Columns 3, 4 and 5 in the table indicate the different ways in which the heat applied has been used.

Column 3 shows us that 262.24 units have been required to raise the liquid from a temperature of 32° to 292.57°. This is called the heat of the liquid and is denoted by the symbol S.

The "internal latent heat," column 4, symbol I, is the heat which has been expended in work, in the process of evaporation, which is the tearing apart of the particles of water against molecular attraction; 832.22 units have been used in this operation.

The "external latent heat," column 5, symbol E, is heat used in the work of expansion, which was the work required to raise

piston in the foregoing illustration. The table shows that 78.27 units were used in this way.

"Latent heat of evaporation," colums 6, symbol L, is the sum of the internal and external latent heat, and would again be given out should the steam condense.

The "total heat of evaporation," column 7, symbol A, is the whole amount of heat required to raise the water from 32° and evaporate it into steam at the pressure taken, and is equal to the heat of the liquid plus the internal and external latent heat.

Column 8, symbol W, shows the weight of a cubic foot of steam at the given pressure, and column 9 the volume in cubic feet which the pound of steam occupies.

Column 10 gives the ratio of the volume of the steam at the given pressure to the volume of the same weight of water when at its greatest density.

Trusting that the quantities and their symbols are now familiar to the reader, let me give one or two examples illustrating their practical use.

Example 1.—A 12 inch steam main (uncovered) 100 feet in length, carrying steam at 45 pounds gauge pressure, is exposed to an outside temperature of 75° Fahr. What will be the amount of condensation per hour?

The internal surface of a pipe of the above dimensions is 314 square feet, and by experiment it has been found that for steam of the pressure taken, the loss by radiation is about 3 heat units per hour per square feet of surface for each degree of difference in temperature between the steam and the surrounding air, for uncovered pipes.

Looking in the steam table for the pressure, 60 pounds absolute (45 pounds gauge), we find the temperature to be 292° Fahr. and $292°-75°=217°$, which is the difference in temperature between the steam and atmosphere. Then from the above data we have $314\times217\times3=204\,414$ heat units lost by radiation.

Looking in column 6, the latent heat of evaporation is found to be 908.9, which means that 908.9 heat units have been used in changing 1 pound of water at 292° Fahr. into steam at the same temperature; and it also means that if 908.9 heat units are taken from the steam, that 1 pound will be condensed into water. So if 204 414 (total heat units lost) be divided by 908.9, it will give the pounds of condensation per hour, which in this case is 224.+.

Example 2.—A jet condenser receives 1 260 cubic feet of steam per minute, at a pressure of 5 pounds below atmosphere (10 pounds absolute). How many pounds of injection water at a temperature of 60° will be required per minute to condense the entering steam, assuming that all the injection water is utilized, that is, raised to the temperature of the condensed steam?

Looking in a steam table we find that a cubic foot of steam at a pressure of 10 pounds absolute weighs .026 pounds and its temperature is 193°.

Then $1\,260\times.026=32.7$ pounds, which is the total weight of steam to be condensed per minute. The table also tells us that the latent heat of evaporation for a pressure of 10 pounds is 979.2, that is 979.2 heat units must be extracted from each pound of steam to condense it into water at the same temperature; therefore $32.7\times979.2=32019.8$, the total number of heat units to be taken up per minute. Assuming that the injection water is raised to the temperature of the condensed steam, we have $193°-60=133$ heat units taken up by each pound of injection water, $32019.8\div133=240.7$ pounds of water required. In practice this amount would be somewhat increased.

Another important application is found in calorimetry, or testing the quality of steam, which will be taken up in a future article.

* * *

To REPOLISH GERMAN SILVER.—Make a thin paste of alkali two parts, ammonia one part, and whiting enough to make of the consistency of cream. Apply with chamois-skin and allow to dry. Then polish with a fine brush.

* * *

THERE was recently rolled at the works of the Stockton Malleable Iron Co. at Stockton-on-Tees, England, a steel plate weighing 12,320 pounds, the sheared size being 76 feet 3 inches by 5 feet by 0.6 inch thick. The width before shearing varied from 5 feet 2 inches to 6 feet 2 inches. Another large plate recently made by the Dowlais Co. in Wales, was 69 feet long, 4 feet 2½ inches wide and 0.6 inch thick; it weighed 8,200 pounds. —*Exchange.*

NOTES FROM NOTOWN.—13.

MACHINE SHOP CALCULATIONS—PUNCTUALITY.

ICHABOD PODUNK.

Mr. B. hired a new man last month, a young fellow of the modern type and one who evidently didn't learn his trade in a piecework shop; he can handle any piece of work we have and give the boys points on most of them, too. He is an unobtrusive fellow, minds his own business better than most of us, but he has a pair of eyes that seem to take in things at a glance. He never bothers the index plate when he's cutting threads—just sizes up the way the lathe is geared and puts on the right gears, while most of us are fingering over the index.

Mr. B. put in a new grinder since the advent of the new man, and having seen that he was pretty quick with figures, he asked him about the right size pulleys to get proper speed. New man told him in a few seconds—figured it out in his head. That set all the boys talking, and the questions asked him within the next few days were amusing as well as interesting. We had a little chat the other noon and I asked him what college he graduated from. "College," said he; "never saw one, not inside, anyhow. See here, Mr. Podunk, I'll tell you just how I came to be a trifle quick at figures. I was serving my time in the Blankville shops, and used to ask all manner of questions of the foreman and everyone else. Figuring lathe gearing was always a mysterious operation to me, and the finding of pulley speeds and similar problems filled me with awe. We had a young draftsman who was good at figures, and after I had made life miserable for him for a month or so he asked me why in helenblazes I didn't learn to figure myself; said he would gladly help me, but that he was everlastingly tired of being bored with such simple questions. I took the bait and started, and in spite of myself he showed me more about shop calculations than I ever dreamed of knowing, and gave me a good start. His great hobby was, 'Know why you do it, and then you won't need the rule,' and it's a right good point, too.

"It wasn't long before I did the figuring for the shop; most of the men were too lazy or thought they couldn't learn, and it kept me in practice. Some thought it was wasted energy, and wouldn't do any good, and I almost came to believe it myself, but the foreman had been watching me, and when he found I could go ahead on any work, calculate my own change gears, the allowance for depth of threads in making taps, speed of milling cutters for best results, and in fact anything I had to do, he gave me the best work and made me his assistant as soon as I was out of my time. Well, to make a long story short, I have always had better work than the average, better pay and am often called in consultation on machine shop, and, while that doesn't pay in dollars and cents, as you probably know, it adds to my value in the shop. I suppose you'll wonder why I'm working at the lathe here like the rest. Confidentially, I am getting familiar with the work, and next month I expect to become assistant superintendent to Mr. B., but keep it dark, Podunk. If a boy asked me the most valuable thing for him to learn in addition to his trade, I should say, 'Learn to make all such calculations as are likely to come up in shop practice. Never mind the higher mathematics unless you expect to use them, but learn all you can about practical shop problems, and there are plenty of them.'" I guess he's right, for I'd give all my old overalls if I could figure out all of the things that come up in my own experience.

The question of making iron-clad rules has been discussed before, but the "punctual attendance" clause is open to grave abuses, and has two (or more) sides to it, as with most questions.

We have a large brass shop in town which is run on ancient castle system, and has its drawbridge, moat and portcullis in all the reality if not glory of the ancient land grabbers. The gate which determines who is late and who not, is operated by a crusty old curmudgeon, who works for eight dollars a week and who cannot see the gate in question, it being operated by a lever in the building. Promptly at 7 A. M., the gate drops, and woe betide the festive derby which happens beneath. The late man or men can come in at 7.30 if it's their first offense for the week; but if the second, they have an enforced holiday until 1 P. M.

Discipline must be maintained, and punctuality is a very desirable feature, for, as everyone knows, twelve men each five minutes late, makes an hour lost on the work. On the other hand, is it

economical for a firm to lose twenty-five minutes work of the man and his machine, because he happened to be five minutes late, perhaps the first time in months? The question of justice to the man is not considered here, only the dollar from a strictly economical view. This is a question which has long puzzled weightier brains than those of a Podunk, and which isn't settled conclusively as yet.

Our Mr. B. has what seems to me the best system in this respect, and it works well here, at least. There's no expensive registering clock, no brass checks or automatic gates—just a little common sense and knowledge of human nature. Mr. B. says to his foreman: "You know we work sixty hours a week, from 7 to 12, 12.45 to 6, except Saturday, when we stop at 4.30 P. M. Men are supposed to be prompt, both getting to work and quitting. If they are not, use a little horse sense before either discharging or reporting. If a man is late three or four mornings a week, and a little moral suasion doesn't work, better tell him he can either be punctual or look elsewhere for a job. If a man happens to be a little late occasionally, say once a month, and you know he is a steady man, perhaps living a long way from the shop, or having sickness in the family, use a little discretion—put yourself in his place, and unless he is quite late say nothing about it; he'll make it up himself if he's the kind of a man we want here, anyhow. I shall hold all the foremen responsible for the work and workmen of their departments; if they lag behind without good reason they'll hear from me, and anything which delays work is to be reported to me immediately."

That's the way he disposes of lateness, makes each foreman his own master and holds him responsible for the work of his room. This means that he will not allow any continued lateness. This might not work in all places, but we have no trouble; and I believe you get more out of a man by making him feel that you think he is human instead of part of the machine he happens to run. It isn't all money, even in this hustling world of ours, and although I wouldn't run a shop as a charitable workhouse, I believe it is economy, in plain dollars and cents, to be as lenient as possible with help of any kind, and to make them feel that you are interested in their welfare, not patronizingly nor for publicity, but in a common sense way.

* * *

ADJUSTABLE BEVEL FOR DRAWING.

B. F. SPALDING.

The system of crossed levers, illustrated in Fig. 1, has some semblance to lazy tongs, and is like them designed to save trouble; it is intended for use in drafting. If three points are set out on the drafting board, the center of a circle which will pass through them may readily be found, and the arc of the circle struck with the dividers, if they are big enough; but when I saw this instrument I thought it had some advantage in doing these things, for it will describe an arc of any circle that is more than an inch in diameter. I don't say there is anything new about it, indeed a very old friend of mine intimates that he saw one before he went into the ark, but it was new to me, and perhaps it may be to some others. I can see, every day, adjustable bevels that run to a sharp corner inside, but I do not very often meet with those that run to a sharp corner outside. This thing appears to be simply an outside bevel which continues its straight lines without interruption to the very corner; and all the ingenuity there is about it seems to have been expended in getting the two

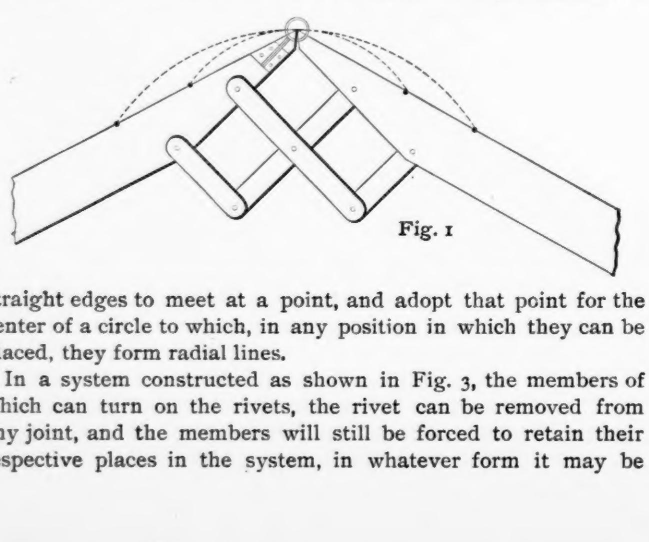


Fig. 1

straight edges to meet at a point, and adopt that point for the center of a circle to which, in any position in which they can be placed, they form radial lines.

In a system constructed as shown in Fig. 3, the members of which can turn on the rivets, the rivet can be removed from any joint, and the members will still be forced to retain their respective places in the system, in whatever form it may be adjusted as the squares elongate into diamonds in any direction. This drawing instrument (Fig. 1) is made so that the pointed ends of the straight edges meet at the point where one of the corner rivets would be in the full system, Fig. 3, and its mate at the opposite corner, being useless, is also left out, and the useless limbs lopped. There is a pencil-holder attached to one of the

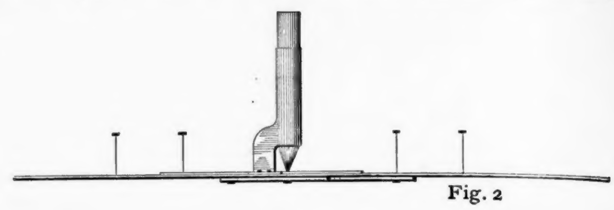


Fig. 2

limbs, which is not adjustable, but is set so that the pencil can be easily sharpened so that its point will come to the point of the straight edges which is the corner of the bevel. This is shown in Fig. 2, which is a side view of Fig. 1.

The way this bevel is used to draw arcs with, when three points are given, is to stick pins in the two outside points, and to set the bevel so that the straight edges bear against the pins when the point of the pencil rests on the intermediate point, and then, still keeping the edges of the bevel against the pins, move

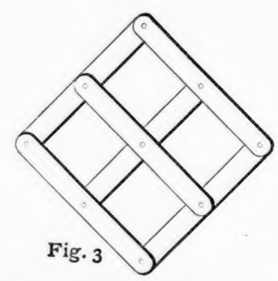


Fig. 3

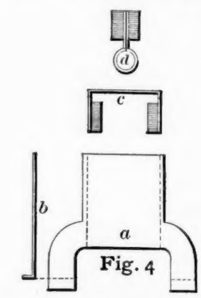


Fig. 4

it until the pencil draws a line from one pin to another. This line will be the arc of a circle which will pass through the three points.

The principle which the bevel works upon is said, in the ancient language of Playfair's Geometry, to be: "The angles in the same segment of a circle are equal to one another." The pins set the base of the segment, and the bevel is adjusted to an angle the point of which coincides with the third given point, which forms the vertex of the given angle in the segment; the movement of the bevel is simply the forming of a continuous series of similar angles in different positions on the same base,

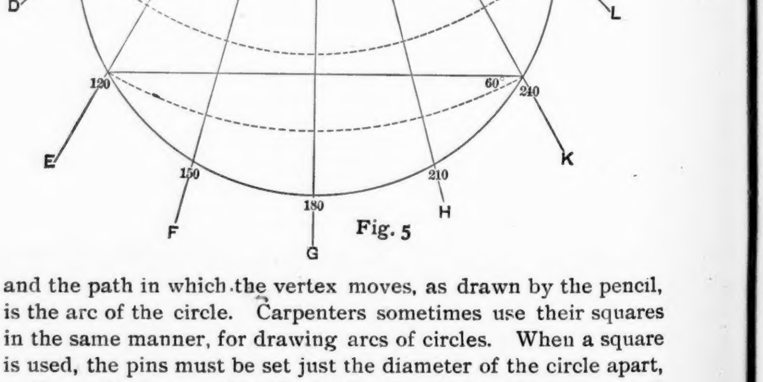


Fig. 5

and the path in which the vertex moves, as drawn by the pencil, is the arc of the circle. Carpenters sometimes use their squares in the same manner, for drawing arcs of circles. When a square is used, the pins must be set just the diameter of the circle apart, as the angles in a semi-circle, being all right angles, the pencil at the corner of a square will describe a half circle. If the bevel is set at a sharper angle than a square, it will describe more than half a circle, and if it is set at a blunter or more obtuse angle, it will describe less than half a circle. If it is set at an angle of

60° it will of course draw two-thirds of a circle. If it is set at an angle of 120° it will draw one-third of a circle.

To find the length of the arc between the two outside points, subtract twice the number of degrees, in the angle formed by the bevel, from 360, and the remainder will equal the number of degrees in the arc of the circle between the two outside points. Thus, in Fig. 1 for instance, the angle of the bevel is 124°, and twice that number is 248, which, taken from 360, leaves 112, which is the number of degrees in both the larger and smaller arcs, represented by the dotted lines.

The reason for taken twice the number of degrees in the angle formed by the bevel from 360, is said to be because "The angle at the center of a circle is double of the angle of the circumference upon the same base, that is, upon the same part of the circumference." This may be seen by an examination of Fig. 5. I would have made the figure so plain that its evidence could be taken at a glance if I could. I allow it will pay for study.

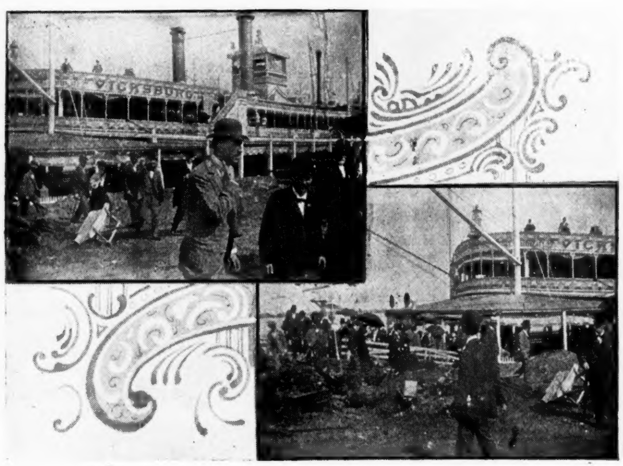
It looks curious to me that, although the radial lines of the semi-circle fall upon the circles at different angles of obliquity, the circles are divided by them as evenly as the semi-circle

Fig. 4, views *a*, *b*, *c*, *d*, show the process of making the pencil holder of sheet metal. It may be rather a small detail, but perhaps not altogether insignificant, as it is part of a drafting instrument which will accurately describe, on a card two inches square, the arc of any circle, from an inch to infinity.

* * *

BEFORE THE TORNADO.

The meeting of the American Society of Mechanical Engineers at St. Louis was held too late in May for us to give any report in the June number, and as the meeting has already been fully reported in all the weekly mechanical papers, we shall only refer to one feature which now has a sentimental interest; this is the excursion to the pumping station of the water works, to which place the party was conveyed in the steamer "City of Vicksburg." The cut published in this connection shows the "advance guard" of the party leaving the steamer at the pumping station landing.



As the steamer "City of Vicksburg" was reported totally wrecked and lost in the tornado only a few days later, it seems almost like a narrow escape for the Society; indeed, the afternoon of the excursion there was quite a fierce storm immediately after the boat got to the levee, with hailstones larger than any ever before seen by the writer. It seems very fortunate for the Society that its meeting took place at the time it did, rather than the following week.

* * *

We have been favored with a copy of a pamphlet entitled "Queer Doings in the Navy," which is a letter from Mr. Asa M. Mattice, a past-engineer in the navy to Congressman Wilson, one of the authors of the Wilson-Squires bill. Mr. Mattice, who was one of the best known engineers in the navy, and whose high standing is certified to by Chief-Engineer Melville and others, shows in a clear and convincing manner the existence of a "ring" or "clique" in naval circles whose power has ever been wielded for the debasement of the engineer and the advancement of its favorites among the line officers. Those who wish to know how laws have been made, un-made and trampled under foot in such a ruthless manner that hardly any engineer is accorded justice, while a line officer is whitewashed when guilty of the gravest charges, should obtain a copy of this pamphlet from their representative in Congress.

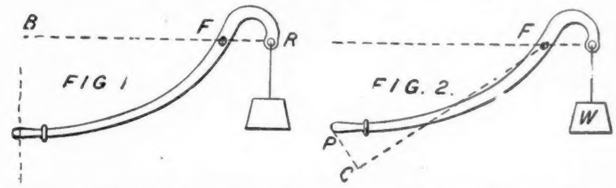
This exposition of facts, which cannot be apparently refuted, should hasten the abolishment of the existing clique and, if possible, secure ample punishment for the leading offenders.

* * *

A FEW WORDS ABOUT LEVERS.

CURVED OR BENT LEVERS.

The effective lengths of their arms are measured by *straight lines* from the fulcrum and points of application of the resistance and of the powers, perpendicular to the straight lines along which the resistance and the power are applied.



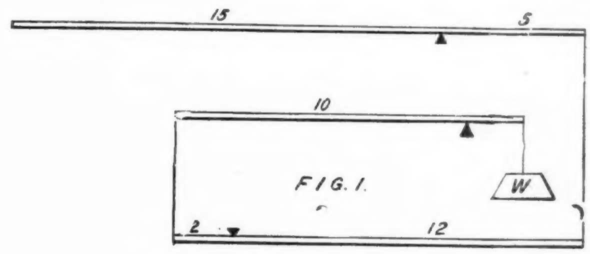
Thus: in Fig. 1 the long arm is F B and the short arm F R. But in Fig. 2, where the power does not pull parallel to the resistance, the long arm is F C, and in this case the leverage is greater.

COMBINATIONS OF LEVERS.

These problems may be worked out either by considering the leverage of each lever separately, or by multiplying all the power-arms together and all the resistance-arms together, and then taking the ratio of the products.

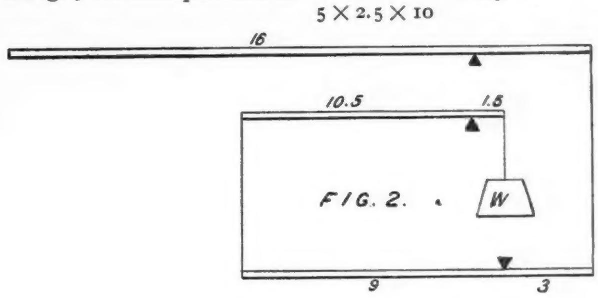
In Fig. 1 we have $\frac{15}{5} = 3$; $\frac{10}{2} = 5$; $\frac{12}{2} = 6$; then the multiplication of power is $3 \times 5 \times 6 = 90$. Or $\frac{15 \times 12 \times 10}{5 \times 2 \times 2} = 90$.

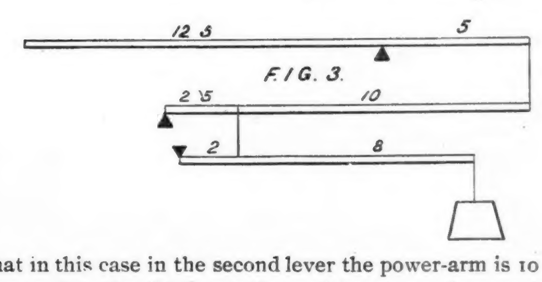
In Fig. 2, $\frac{16 \times 3 \times 10.5}{4 \times 9 \times 1.5} = 9\frac{1}{3}$.



Note that in Fig. 2 the under lever loses power because the power-arm is shorter than the resistance-arm.

In Fig. 3 the multiplication is $\frac{12.5 \times 12.5 \times 2}{5 \times 2.5 \times 10} = 2.5$.





Note that in this case in the second lever the power-arm is $10 + 2\frac{1}{2}$, not 10; and in the third one the resistance-arm is 10, not 8. The third lever loses power and gains resistance and speed.

If it is constantly remembered that when we gain speed we lose power, and vice versa, there will be fewer attempts at perpetual motion.

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C. H. Benjamin.	"Jarno."	R. D. O. Smith.
W. A. Carlile.	W. J. Keep.	Walter B. Snow.
Rolla C. Carpenter.	Strickland Kneass.	Theo. F. Scheffler, Jr
Francis W. Clough.	W. Barnet Le Van.	Fred'k A. Scheffler.
"Cisnarf."	W. B. Mason.	L. S. Starrett.
John H. Cooper.	"M. E."	B. E. D. Stafford.
William Cox.	A. K. Mansfield.	Robt. H. Thurston,
James Christie.	M. D. Nagle.	John T. Usher.
F. H. Daniells.	H. M. Norris.	W. H. Wakeman.
P. S. Dingey.	Howard A. Pedrick.	Jay M. Whitham.
G. W. Dickie.	Thos. P. Pemberton.	Geo. P. Whittlesey.
W. D. Forbes.	Fred H. Perry.	Edward J. Willis.
Geo. L. Fowler.	W. E. Partridge.	Thomas D. West.
Frederick Fosdick.	"Quirk,"	Warren E. Willis
Lester G. French.	W. B. Ruggles.	Samuel Webber.
S. W. Goodyear.	Richard H. Rice.	Wm. O. Webber.

THE editorial and news columns of this journal are not for sale, and under no circumstances will any matter be inserted therein for pay, or in consideration of advertising, or on account of the purchase of copies of the paper.

WE solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense.

ALL copy must reach us by the 10th of the month preceding publication.

THIS PAPER HAS THE LARGEST CIRCULATION OF ANY PUBLICATION IN THE MACHINERY TRADE

AUGUST, 1896.

BUSINESS IN NEW ENGLAND.

Numbers of the larger machine shops in New England are running full time with plenty of work ahead; a few on domestic, but most on foreign orders which will make the difference between profit and loss to many a manufacturer this year. In Providence, the Brown & Sharpe Co.; in Worcester, Prentice Bros., the Powell Planer Co, the Norton Emery Wheel Co, the Wheelock Engine Co; in Nashua both the Flather shops; in Fitchburg the Becker Mfg. Co. and Fitchburg Steam Engine Co. are running full time, having enough business for months to come. The D. E. Whiton Machine Co. of New London and the Union Mfg. Co. of New Britain are employing all the men they can work, and both concerns are building additions to their shops to accomodate their increased business. The employees of these concerns and others like them have cause to rejoice when so many of their neighbors are without employment or looking into the future with trembling and uncertainty, for which they may thank the political party whose declaralast month at Chicago struck with a palsy the slowly reviving industries of the country.

* * *

BEGINNING with September, the subscription price to MACHINERY will be one dollar, postage paid, to all parts of the world; and single copies can be bought for ten cents everywhere. In other words, the readers of MACHINERY in London or Yokohama can obtain their papers for the same price as those in New York or Hartford.

* * *

ONE MORE WORD ABOUT CIRCULATION.

(1) The *American Machinist* is not sent broadcast free.

(2) The American News Co. sells more than *one thousand two hundred copies a day*, every work-day in the year—and have for years.

(3) Four thousand seven hundred and thirteen (4,713) subscribers receive their paper direct from this office.

(4) When the traveling undertaker asks you to look into the morgue of his circulation figures to see the corpse of the *Machinist*, just ask him if a news stand sale of *1,200 a day* year in and year out, is not rather an extraordinary circulation for a corpse.

(5) What good would a million circulation do you if it didn't reach the ten thousand men who ought to use your goods? The *American Machinist* does reach them.—*American Machinist*, July 9, 1896.

Intelligent readers are not generally interested in circulation "wars," and it is a mistake for a paper to take them up. We don't propose to enter one, and quote the above extracts from our contemporary only to corroborate, in a good natured way, the following statement made in June MACHINERY. ". . . . During which period the average circulation (of this paper) was 14,958 copies each issue. To the best of our knowledge and belief this circulation was about fifty per cent. greater than that of the *American Machinist.*"

Quoting from our contemporary's statement: 1,200 copies a day (2) is 7,200 copies a week, plus 4,713 subscriptions (3) equals 11,913 copies each issue, which we know to be more than the circulation before the present enterprising management took hold.

(1) During the first six months that MACHINERY existed it *was* "sent broadcast free." The paper then had less than half its present number of pages, and this was the most effective way of letting people see what it was like. This free broadcast distribution brought us thousands of subscriptions; but when the country had been thoroughly covered in this way we discontinued it, and now send out free copies to the same extent only that our contemporary does—to exchanges, advertisers, etc.

(4) We don't know who the "traveling undertaker" may be, but we do know that no person connected with this paper ever said one word against the *Machinist* or its corpse. It doesn't pay to abuse your competitor, as the former owners of the *Machinist* discovered; and we haven't time for that sort of work if it did pay.

(5) There are more than seven hundred thousand people in the United States alone who are interested in and connected with the machinery trades. No single paper reaches them all, even indirectly; no paper can. As for the "ten thousand"—if an advertiser could be sure of reaching *his* ten thousand through any single paper, that is the one for him to go into; but they are so scattered through the seven hundred thousand that he can't be certain what proportion one paper does reach. The facts are that the *Machinist* reaches some, MACHINERY reaches some (you see we're polite, neighbor, and name ourselves last); neither paper reaches them all.

Moral: Advertise in both—that's what we tell manufacturers who ask our advice.

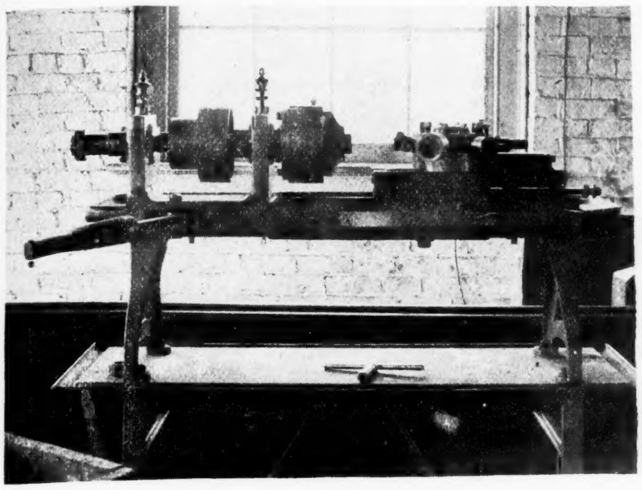
* * *

ONE of the ar[illegible]ng sides of the horse power question, is the oft repeat[illegible] tale of the steam locomotive being pulled around at the mercy of the electric or other motor, and the conclusion follows that the other motive agent is more powerful than steam. This is immediately picked up by the thoughtless without stopping to think that it is a question of the *amount* of power exerted and not the particular *kind*. If the electric motor pulls the most, it is exerting the most power and vice versa, and the only question is, which form of power is most convenient and which can be applied at the lowest cost.

A FEW OLD TOOLS.

There is often much of interest in some of the old tools that are occasionally found in the shops. Probably one of the first turret lathes or screw machines is the one by Mr. E. K. Root, who was connected with the Colt Armory in its early days, and who made the machine shown herewith for use in making some of the turned portions of the gun work, what is now known as screw work.

This has a stop screw behind as shown, but has no automatic tripping device. The pilot wheel or lever on turret is missing



OLD TURRET LATHE, BY E. K. ROOT.

from its accustomed place, but can be seen at the left under the headstock, and though it would probably be in an awkward position for one who was accustomed to the modern machines, we are assured by those who have run this type of machine that it is really convenient, as it leaves the right hand free for chucking work, etc. This was found in the shops of the Billings & Spencer Co., Hartford, Conn.

Among the early builders of planers in this country probably Dwight Slate, now of Hartford, Conn., was one of the best

ONE OF THE FIRST GEARED PLANERS.

known, and Slate & Brown were one of the first regular builders of planers. The one shown was built in the 40's, at Windsor Locks, Conn., by this firm and, as will be seen, its table was driven by rack and spur gear, as so many are to-day. The first ones we know of were driven by chain, either the regular bent link chain or the flat link for sprocket, as shown in the old planer found at the Silver & Gay Co., in North Chelmsford. The planer here shown is a very complete tool for its day and had an ingenious belt shifting device on the opposite side, which was unfortunately not well lighted as well as being un-get-at-able on account of debris of various kinds. This was found in the old Clapp shop, at Northampton, Mass.

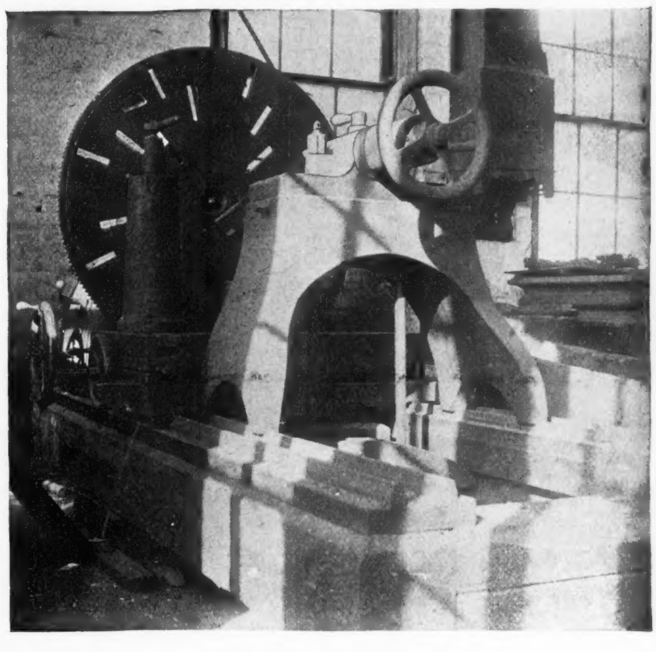
In the same shop was an old lathe which had some interesting features and which is shown in the next illustration. It is a fairly large lathe, having a swing of probably 36 inches and the usual old time arrangement for obtaining feed for the carriage, which could be reversed by throwing a couple of small bevel pinions either to right or left, as desired. It needs little explanation, but is worth a passing notice as a step in the development of the modern lathe.

* * *

THE QUESTION OF "SPHERE."

SLOW PAY.

When I was an apprentice boy in a machine shop, along came a new boy whom we, the rest of the boys, in accordance with the established custom of conferring nick-names, at once dubbed "Schweitzer." Schweitzer didn't seem very bright, and didn't get along very well at the trade, and I am afraid we held him in considerable contempt, thinking that a boy who didn't know enough to learn how to butcher iron didn't amount to much; but when Schweitzer finally got his walking papers for incompetency, our contempt was turned more or less to pity, for we really didn't see how Schweitzer was to live. Our pity was soon changed to mirth when we saw Schweitzer walking around town peddling bologna sausage from a basket. Mirth was succeeded by surprise when we discovered that Schweitzer had hired a cellar



AN OLD LATHE, WOODEN BED.

somewhere, and was *making* his sausage as well as selling it. Wonder followed soon on the heels of surprise when we discovered Schweitzer not very long after, peddling his sausage from a cart to which was attached a quadruped; nothing very high toned, but still a team. Then came amazement when we saw Schweitzer going around with a nice covered wagon drawn by a *good* horse, and neatly painted on the wagon a legend as follows: "Schweitzer, Manufacturer of Bologna, Deerswim, Conn."

No word can express our feelings when we saw that Schweitzer had actually opened a neat store on the principal street, and was selling a full line of German delicacies, and we were more than dumbfounded when Schweitzer bought the whole block in which the delicatessen store was situated.

This may all seem out of place in a paper devoted to machinery interests, but there is a moral applicable to any business, which might be stated thus: It isn't *what kind* of work you do, so much as *how you do it*, that counts for success or failure.

There are lots of men making a big failure of the professions, who would be successful machinists; and my opinion is that it is better to be a good machinist than a bad lawyer or doctor, and by the same token that it is better to be a good maker of bologna sausage than a bad machinist, without taking into account at all the factor of the brick block that Schweitzer owns, and that some of the fellows who used to laugh at him don't own—and for that matter, they don't own any other block, either.

SELECTING BOILERS FOR MILLS AND FACTORIES.

W. H. WAKEMAN.

Very few manufacturers and steam users are competent engineers; neither are some of the men who select boilers for use in our stationary plants capable of judging of the merits or the short comings of the different types of boilers that are so freely advertised, and for some of which extravagant claims are made. If a manufacturer has a 500 horse power engine he may order 500 horse power of boilers to run it with, and not have even the most remote idea of what that 500 horse power really means.

For illustration I will refer to the case of a mill owner who needed boilers to run an engine that rated at 150 horse power. He informed several manufacturers of tubular boilers that he wanted two 80 horse power boilers and asked for prices. He rather favored two of these parties from the start, but when he received their respective bids he found a great difference in the prices asked, and immediately closed with the lowest bidder. Now I would offer no objection to this provided the boilers were to be of the same size and quality but in this case they were not, for when the low priced boilers were installed, he discovered that there were no domes on them, while the other party had calculated on furnishing large, well made domes. I am well aware of the fact that many good engineers do not believe in putting on domes, but this does not enter into the question at this time, for if it had been understood that no domes were wanted, the other party could have made a lower price than he did.

The boilers furnished were 15 feet long while the unsuccessful bidder had intended to furnish boilers 18 feet long. Furthermore the low priced boilers had only small hand holes in the heads below the tubes, and they had as many tubes as could be crowded into the lower part of the shells because a given number of square feet of heating surface can be furnished in this way cheaper than by making a boiler longer or large in diameter. The higher priced boilers would have had large man-holes below the tubes, not only making it possible for a man to go into the shells when cleaning and inspecting them and affording room in which to make repairs, but providing a solid body of water directly over the fires at all times when in service. One bidder had rated his boilers on a basis of 12 square feet of heating surface per horse power, making $80 \times 12 \times 2 = 1920$ square feet in all, while the other had intended to furnish 15 square feet per horse power or $80 \times 15 \times 2 = 2400$ square feet, showing that there was a good reason for his higher price, and also demonstrating that his boilers were really the cheaper when all things were considered.

When manufacturers who want boilers simply state the number of horse power that they require and ask for bids on that basis alone, they favor those boiler makers who furnish the least material and the lowest grade of workmanship that will be accepted by an inspector; and, furthermore, such a course puts a premium on dishonesty, for I regret to say that there are some dishonest boiler makers in this broad land of ours.

In another case that was brought to the notice of the writer, a manufacturer wanted one tubular boiler, and inspected the stock carried by two or more boiler makers, comparing prices for same. The lowest priced boiler was of course, of inferior design and not of the best workmanship, but the steam user decided to take it after some changes that he desired had been made. It should be noted that he selected a boiler that was carried in stock, as he expected to get better value for his money by taking one that was made when work was not driving, than he would to order one made; specifying that it should be delivered within a given time, and in order to satisfy himself that he secured the boiler selected, he had a private mark put upon it. In due time the boiler arrived at his shop and was put into place, but the private mark could not be found. Quiet investigation brought out the fact that instead of making the required alterations in the stock boiler, a new one had been made in four days time, and instead of securing one that had been made at their leisure, he found that he had one that was made in the shortest possible time, and it is presumed that the workmanship was not improved by the the short time allowed, although it is possible to build a good boiler at short notice. It is unnecessary to add that nothing was done about it, as it would have been an expensive and unsatisfactory job to attempt to secure the boiler actually purchased.

The steam user who purchased the pair of boilers rated at 80 horse power each, soon found that it was only by forcing them that he could secure the necessary steam to do his work, and the plant was frequently shut down on this account until a new engineer was hired who adopted methods which made it possible to run ten hours per day; but it was hard work, and after a time it was necessary to put in another boiler. The reason for this was as follows. Although the engine was rated at 150 horse power, no measures were taken to ascertain how much power was actually called for, neither was any allowance made for increase of capacity of mill; consequently when the engine was indicated and found to be developing more than 150 horse power, which was graduallp increased until it required more than 200 horse power to operate the machinery, no further reason was needed for the necessity of forcing the boilers.

Speaking of an 80 horse power boiler suggests the question of what constitutes a horse power in a boiler. Some writers tell us that there is no such thing, but I claim that the horse power of a boiler is a quantity that is just as well defined as the horse power of an engine, for taking an engine with a cylinder of a given size we cannot tell what the power of it will be until we know the speed of the piston, and the mean effective pressure of the steam. So it is with a boiler, for we cannot tell what power it will develop until we know the amount of water evaporated, the steam pressure carried and the temperature of the feed water. Raising 33 000 pounds one foot high in 1 minute of time, or its equivalent, constitutes one horse power in an engine.

The evaporation of 30 pounds of water per hour from feed water at 100° Fah. into steam at 70 pounds pressure constitutes one horse power in a boiler. Is there any good reason why we should accept one and reject the other? The claim that either one of them is too large or too small to suit the notion of some one, does not effect the case at all, for both of them are arbitrary standards fixed for the purpose of comparison, and as such are sufficient for the purpose intended.

It is true that comparatively few boilers are run at 70 pounds pressure and fed with water at a temperature of 100°, but that signifies nothing, for it is a very easy matter to establish an equivalent for this quantity, taking the conditions as we find them. If we take water at zero of the Fahrenheit scale and evaporate it into steam of 70 pounds gage, or 85 pounds absolute pressure, we must put a total of 1210° of heat into it, and if the feed water as it enters the boiler has a temperature of 100° then we must put $1210 - 100 = 1110°$ or heat units into each pound of it, and when 30 pounds of it are evaporated, calling for $30 \times 1110 = 33300$ heat units, we have developed one horse power in our boiler. Degrees and heat units are not interchangeable terms except when the quantity of water is stated at one pound, as a heat unit is the amount of heat required to raise one pound of water one degree in temperature, or from 39 to 40° Fah. while degrees may refer to any quantity of water.

If the temperature of the feed water is 210°, then we must put $1210 - 210 = 1000$ degrees into each pound of it. It requires 33 300 heat units for one horse power, therefore in order to ascertain the number of pounds that it will be necessary to evaporate under these conditions, in order to develope one horse power, we must divide 33 300 by 1 000 and our quotient is 33.3 pounds. Therefore in developing 100 horse power in a boiler at 70 pounds gage pressure and feed at 100 degrees, we evaporate $30 \times 100 = 3000$ pounds of water per hour, but if the feed is at 210° we must evaporate $33.3 \times 100 = 3\,330$ pounds per hour.

Presenting the matter in another way, suppose that with 70 pounds gage pressure and feed at 100 degrees we have evaporated 4 500 pounds of water in an hour. How much power have we developed? As 30 pounds under these conditions constitute a horse power, $4\,500 \div 30 = 150$ horse power. But suppose that our gage pressure is 115 pounds (130 pounds absolute) and the feed is at 210 degrees. When we have evaporated 4 500 pounds of water in an hour, how much power have we developed? Steam at 130 pounds absolute pressure contains 1 220 degrees of heat, and as the feed is at 210, then $1\,220 - 210 = 1\,010$ degrees of heat units to be put into each pound to evaporate it. We have already shown that it requires 33 300 heat units for a horse power, so that in order to ascertain the number of pounds to be evaporated for one horse power under these conditions, we divide 30 000 by 1 010 and our quotient is 32.97 pounds. The total evaporated is 4 500 pounds, therefore $4\,500 \div 32.97 = 136$ horse power developed. A short time spent in studying the above will show any one that it is possible to apply it to any conditions that may be found in practice.

In order to make use of the foregoing in selecting a boiler, it

will be necessary to know the amount of water per horse power that the engines will require. If 30 pounds are needed then the engines and the boilers may be of the same rated capacity, except that in all cases it is well to have plenty of boiler power, say 10 per cent. in excess of the actual rated capacity of the engines. If the engines are of a high grade, so that the builders will guarantee a horse power for each 15 pounds of water, then the boilers will need to be but one half of the capacity of the engines, and so on according to the efficiency guaranteed by the engine builders, for at the present time no man should buy an engine without a guarantee of its performance, and it should not be accepted unless it makes good this guarantee.

A very important point to be taken into consideration is whether the plant shall be designed so that the boilers will do their work with slow fires under them, or have to be forced in order to keep the plant in operation. The horse power that can be developed does not settle this, for some plants have much greater capacity than others, while doing practically the same work. Which of these is the most economical in the long run, is the question that interests the steam user. When the statement is made that if a small boiler plant is installed and run to its utmost capacity, the original cost of boilers and ground on which to locate them, the interest account and cost of insurance will be comparatively small there is no chance for argument, as we know this to be the case; but when economy of fuel, durability of boilers, cost of repairs and ability to run continuously are to be taken into consideration, it is well to give the matter thorough investigation. The economy of fuel will first be considered, as that is a large item in the cost of running a plant, and for this purpose I propose to introduce in the next issue the results of some tests made by reliable engineers, having selected them from a very large number at hand, giving the essential points in condensed form, and making only fair comparisons for the benefit of our readers.

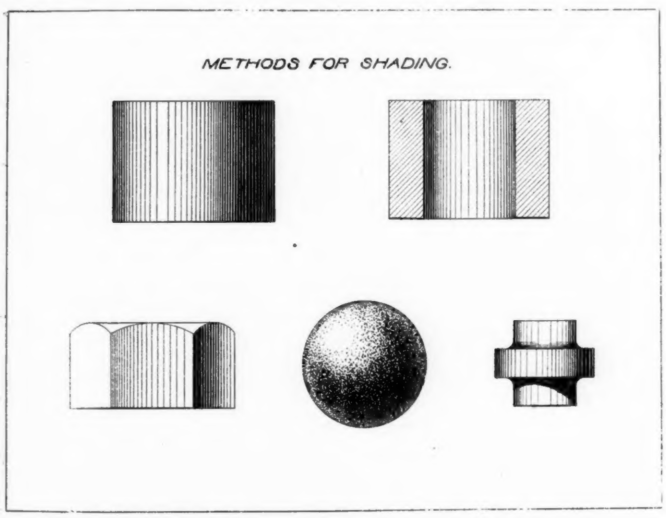
* * *

PRACTICAL TALKS ON MECHANICAL DRAWING.—(9).

LOUIS ROUILLION.

SHADING.

The elaborate shading of finished drawings is now seldom attempted. The purpose of such drawings is much more cheaply and satisfactorily attained by the aid of photography. To correctly shade a drawing requires exceptional ability and much time, and any advantage that a shaded drawing may possess is not commensurate with the expense involved in the making of it. For those who may be interested in the methods made use of in shading, a sheet of such methods is here introduced.



The shaded effect upon the cylinder is obtained by varying the thickness of line and space. Where the light is supposed to strike the object directly is indicated by fine lines and wide spaces. The lines become wider and the spaces narrower towards the right. The part of densest shading is almost at the extreme right.

The sphere is shaded by dotting with the point of the pen. The darkest part is crescent shaped.

ISOMETRIC PROJECTION.

A cube drawn in isometric projection presents the appearance shown in Fig. 39. By noting certain peculiarities of the drawing of the cube the principles of isometric projection can be readily deduced. The term "isometric" implies that the lengths of the sides of each face are equal. In the case of a cube, therefore, the lines would all be equal in length. Again it will be noticed that the three angles about A are equal and are, therefore, of 120° each. That is, each of the top lines of the faces are drawn at an angle of 30° to the horizontal. This also holds for the bottom lines. The side lines are drawn vertically. From these observations, then, we may lay down the following rules for making an isometric drawing of a cube:

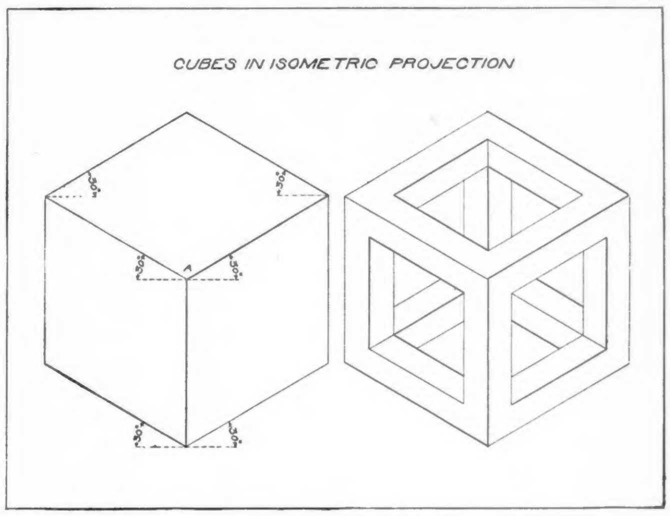


FIG. 39.

Draw all lines their true length.

Draw all vertical lines vertically.

Draw all horizontal lines at an angle of 30° to the horizontal; those of right hand faces to the right and of left hand faces to the left.

These simple rules hold for all objects composed of faces at right angles to each other. Such an object is shown in the skeleton cube in Fig. 39. Let this cube be 3 inches high and the frame be ½ inch square. First draw the center line 3 inches in height and then the 3-inch lines composing the tops and bottoms of the side faces, at 30° to the horizontal. After the outlines of the cube are thus obtained, show the thickness of the frame by drawing lines parallel to those just drawn and at a distance of ½ inch.

Fig. 40 shows two mortice joints drawn in isometric projection.

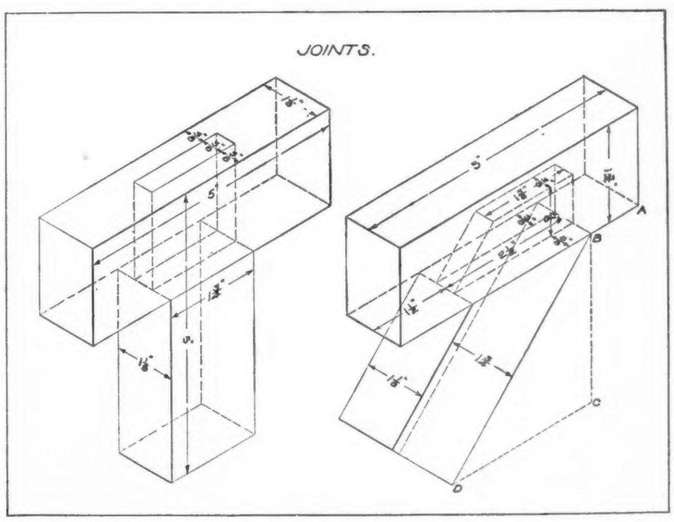


FIG. 40.

Each line in the joint at the left of the sheet is the actual length of the line and the drawing may be scaled from on any part. This is true because every line of the joint is at right angles to the next adjacent line. Or, to state it in other words, the faces are contained in planes that are either parallel or at right angles to each other.

In the joint to the right in Fig. 40 is an example wherein some of the lines are not at right angles to the adjacent lines. These call for a peculiar treatment, which consists in determining the position of the ends of the lines by a system of right-angled dis-

tances from some starting point. For example, supposing the upper part of the joint to be drawn and it is desired to draw the lower part: locate the point B by its distance from A. Now, as the point D is not in a line at right angles to A B, it becomes necessary to determine its position by offset lines at right angles to A B. We therefore measure directly downwards from B a distance B C, equal to the distance that the point D is below the line A B, and then measure the distance of D from C. The position of the point D is thus established, and D and B are joined by a straight line. The other lines of this part of the joint are drawn parallel to the line B D.

One of the disadvantages of the use of isometric drawings is here brought out, that all lines not in the three isometric planes are distorted from their true length. Thus the line B D measures on the joint $4\frac{3}{16}$ inches, whereas the line on the drawing measures

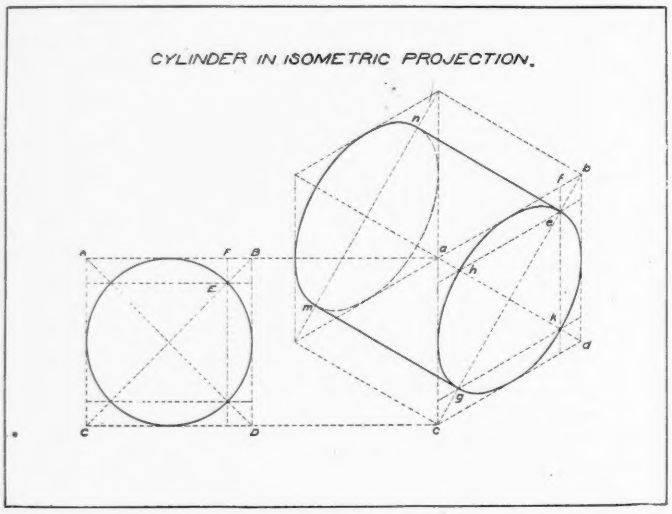


FIG. 41.

$5\frac{1}{8}$ inches. This distortion can be clearly shown by making an isometric drawing of a square box with a lid. By making the drawing with the lid closed or opened at a right angle to a face of the box, the lid will have its true measurement. But draw the box with the lid thrown back, say, at an angle of 120°, and the lid becomes much too large for the box.

Fig. 41 shows an isometric drawing of a cylinder 3 inches in diameter and 3 inches high. The principle for drawing the cylinder is applicable to any curved line. It consists in locating a number of points on the curve by offsets at right angles, as the point D, in Fig. 40 was, determined. This will be readily understood by a careful consideration of the method by which the cylinder is drawn. First enclose one face of the cylinder in a

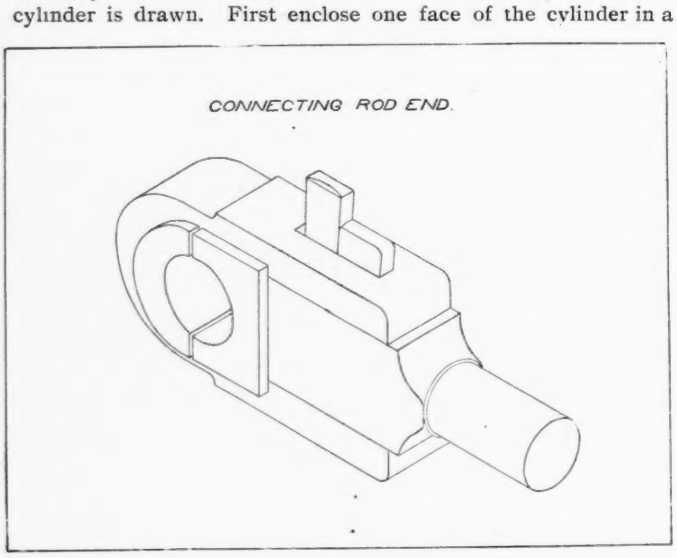


FIG. 42.

square A B C D, and make the isometric drawing of the square, as *a b c d*. As the circle touches the square A B C D at the middle point of each of the sides, so it will touch the middle point of each of the sides of *a b c d*, and thus four points of the curve are determined. Any other point of the circle, as E, may be located by taking distances at right angles from some predetermined point, as B; *e g*, *b f* equals B F, and *f e* equals F E. Having found a series of points join them by a smooth curve. This curve proves to be an ellipse having a major axis *e g* and a minor axis *h k*. Next draw the lines *g m* and *e n* equal to the height of the cylinder, and repeat the ellipse of the front face.

Fig. 42 shows a connecting rod end drawn in isometric projection. The part of the rod shown in the drawing is practically the same problem as that shown in Fig. 41, and illustrates the application of the method for drawing circles or other curves.

Cavalier projection presents some advantages over isometric

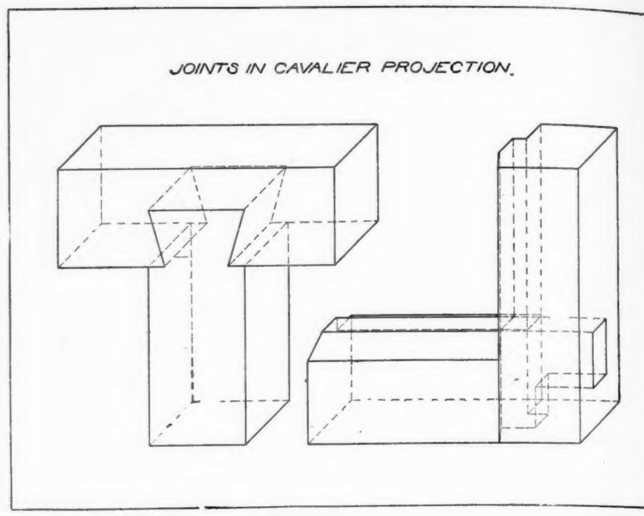


FIG. 43.

projection, in that one face of the object is drawn to its correct proportions, and that circles lying in the plane of the paper are represented in circles in the drawing.

In Fig. 43 two joints are shown in cavalier projection. The front faces are drawn to their correct proportions, and the side lines are drawn their true length, but at an angle of 45°. The method is extremely simple and is clearly shown by the examples given.

* * *

SAFETY VALVE LEVERS.

WILLIAM COX.

To ascertain the weight to be attached to the end of a safety valve lever involves the consideration of three points, namely, the pressure due to the weight itself, the pressure due to the weight of the lever and the pressure due to the weight of the valve and spindle. In the case of any given safety valve the two last points are constant when the length, diameter and weight of the lever and valve are constant. We will therefore examine these first.

The pressure in pounds per square inch due to the valve and spindle is found by

$$\text{Pressure} = p_2 = \frac{v}{A} = \frac{v}{0.7854\,d^2} \quad (1)$$

Where v=weight of the valve and spindle,
A=area of the valve,
d=diameter of the valve.

The pressure in pounds per square inch due to the weight of the lever is ascertained by

$$\text{Pressure } p_1 = \frac{w \times g}{A \times l} \quad (2)$$

Where w=weight of the lever,
g=length of the lever from the fulcrum to its center of gravity,
l=length of the lever from the fulcrum to the center of the valve.

To ascertain the pressure in pounds per square inch exerted by the weight at the end of the lever, we have

$$\text{Pressure } p = \frac{W \times L}{A \times l} \quad (3)$$

Where W=weight attached to the lever in pounds,
L=total length of the lever.

It is now evident that the total pressure of the steam in pounds per square inch at which the valve will open is

$$\text{Pressure } P = p + (p_1 + p_2) \quad (4)$$

where, as stated, $(p_1 + p_2)$ is a constant. It will also be seen that $A \times l$ which is found in equations (2) and (3) is a constant for any given safety valve.

Combining equations (3) and (4) we have

$$\text{Total pressure } P = \frac{W \times L}{A \times l} + (p_1 + p_2) \quad (5)$$

whence

$$\text{Weight } W = \frac{A \times l}{L} [P - (p_1 + p_2)] \quad (6)$$

and

$$\text{Length } L = \frac{A \times l}{W} [P - (p_1 + p_2)] \quad (7)$$

Example.—

Let $L = 40$ inches $P = 120$ pounds.
$l = 4$ " $w = 12$ "
$g = 15$ " $v = 6$ "
$d = 3$ " then $A = 7$ square inches.

By equation (1):

$$p_2 = \frac{6}{7} = 0.86 \text{ pounds per square inch.}$$

By equation (2):

$$p_1 = \frac{12 \times 15}{7 \times 4} = 6.43 \text{ pounds per square inch,}$$

therefore $p_1 + p_2 = 6.43 + 0.86 = 7.29$, a constant in all cases of variation of steam pressure and weight, for this lever.

Now by equation (6):

$$W = \frac{7 \times 4}{40} (120 - 7.29) = 0.7 \times 112.71$$

= 78.9 pounds = weight to be attached to the end of the lever to balance a steam pressure of 120 pounds.

In the same way, should it be desired to balance any other steam pressure, say 100 pounds per square inch, the position of the weight W on the lever is found by equation (7), thus:

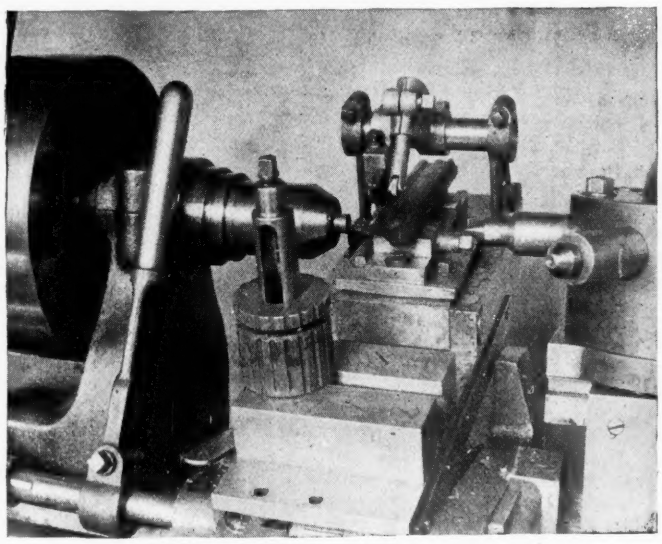
$$L = \frac{7 \times 4}{78.9} (100 - 7.29) = \frac{28 \times 92.71}{78.9}$$

= 32.9 inches from the fulcrum. Having thus found the position of the weight for any given pressure, the calculations for any other pressures, for the purpose of marking the lever, are very easily ascertained by equation (7), in which $\frac{A \times l}{W}$ and $(p_1 + p_2)$ are now both constants.

* * *

AUXILIARY TOOL-HOLDER FOR FORMING LATHES.

The growth of the use of the forming lathe for finishing castings has created a demand for the use of the same methods on finishing pieces made from rods. These need to be cut from the rod after turning, and are usually of such a nature that knurling



AUXILLIARY TOOL-HOLDER FOR FORMING LATHES.

and other operations are also called for. The cut shows a cutting-off tool and knurling-wheel holder in addition to the regular forming tool. The tools are evidently adjustable in every direction, and other and more tools can be used in the same manner and at the same time if required, and the construction is such that any tool can be removed and ground without disturbing the adjustment of the rest of the tools.

It is evident that a piece having been turned from a rod, is cut off by simply continuing the forward motion of the forming tool slide, and as the same lever that works the chuck also moves the slide (and as the rod is automatically fed forward to a stop as soon as the chuck is opened), there are many pieces that can be turned and cut off by simply "pumping" the lever forward and backward, the hand not being removed from the lever at all until necessary to put a new rod in the wire feed.

Made by the Meriden Machine Tool Co., Meriden, Conn.

* * *

HORSE POWER OF A STEAM ENGINE—FOR THE BOYS WHO DON'T GO TO COLLEGE.

GLENN FRANKSON.

I had served a regular enlistment as apprentice in a machine shop, been freed because my term of enlistment had expired, and had rattled around as a "jour" for some time before I had a rational conception of what a horse power really was, or what the expression actually meant when applied to the performance of a steam engine. It was a plain case of rather lamentable ignorance. When later on I ran myself right up against a shop where they built a considerable number of steam engines for special purposes, and a little later on the proprietor rather insisted that I take hold of this branch of the business, and plan for power and size of an engine that was required for this machine and the other. I was young, and it would have saved me many a sleepless night if I had spent just a little of my leisure time during my apprenticeship in studying up horse power and many other things connected with the steam engine. There was some excuse for ignorance on such matters in those days. You could scarcely find anything in print on them compared to what can be found to-day. The spread of technical journalism has placed much within reach of the apprentice. He can afford a few cents to pay for a paper, when ten dollars for some elaborate book from which he could get but little information, was quite beyond his means. However, ignorance is still dense enough for all practical purposes.

The boy may go to the machinist trade, serving his time in a shop where no steam engine work is done, get along nicely enough with his trade, and find that he would like to strike a job in a shop where steam engines are built. This is more than likely. There is a fascination about "the great prime mover" that seems to cling right to it, to the enticement of most young machinists. I don't blame them, even a little, for being enticed; for seeking a better acquaintance with its construction and operation. It makes the "wheels go round." It represents, if a perfect machine, the poetry of motion, and claims and holds the attention of all. I have never yet seen the mechanic, in whatever branch of the business he might be, who did not like to watch the methodical turning of a large steam engine. It seems more like something sentient than like a thing of iron and steel.

I confess that in crossing the Atlantic I have, through the courtesy of the chief engineer, and in a lazy mood, sat by the hour and listened to what the engine said; listened to its low tones and translated them into the English language that would become, after a little, as plain words as if they were actually spoken. And I was assured by our very intelligent chief engineer that since he came to handling triple expansion engines he invariably translated the slight noise into words, and that the slightest variation would arouse him from the deepest slumber. As he put it, the engine was trying to say that there was trouble impending, probably some oil-cup was not feeding properly.

I might say that so far as words are concerned our translations did not agree very well, probably owing to lack of knowledge of the language of the triple expansion marine engines, or what amounts to the same thing, to his better knowledge. But this is digression; just what was referred to in the title.

I am told by editors of technical journals that a goodly proportion of the questions asked by their readers have reference to the steam engine, and a large share of these to the probable horse power of an engine, actual or proposed. This is natural enough; it only shows the interest in the matter.

Watt, as is well-known, based his calculations of steam to supplant horses on the assumption that a horse working regularly would lift a weight of 33 000 pounds one foot high in one minute

of time, and this is the basis for calculation of horse power in use amongst English speaking people. It is a unit of power.

It does not matter to-day whether a horse can or cannot lift 33 000 pounds one foot high in a minute. The old-time Pennsylvania steam engine builder who, when questioned by a probable customer as to the horse power of an engine under discussion, replied, in all earnestness, that it made all the difference in the world whether he referred to Pennsylvania horses or to New Jersey horses, was right enough, probably, in the way he looked at the matter. His idea was to build an engine that should do the work of so many horses, but he must know something about the horses. To-day it does not, nor would not, make any difference whether a horse can lift 33 000 pounds or 5 000 pounds in the time specified. The understanding is universal amongst English speaking folk, as intimated, and the unit is just as good left at a horse power as it would be if changed to anything else.

With this as a unit--33 000 pounds lifted *one* foot high in *one* minute of time equals a horse power—we come at the matter very readily.

The *total* effective pressure, acting against the piston to move it forward, is the pressure acting to that end. less the pressure that opposes it. It is usually quite different, this pressure is, at different periods in the stroke, but is averaged for the whole stroke. This total pressure is found by multiplying the area of the piston in square inches by the mean effective pressure per square inch, which is the *progressive* pressure per square inch less the retarding—the back—pressure, and is designated by the letters M. E. P. This provides for the simple formula:

$$\frac{A \times M.E.P. \times S}{33\ 000} = \text{horse power.}$$

In this formula A = area of piston in square inches, M. E. P. = mean effective pressure per square inch, and S = speed of piston in feet per minute. Thus, let A = 100, M. E. P. = 40, and S = 500. Then

$$\frac{100 \times 40 \times 500}{3\ 300} = 60 + \text{horse power.}$$

But there is more to the matter than this. How do we know what the M. E. P. will be? This depends upon the way we can get steam into and out of the cylinder. And when we want to know the horse power of a steam engine we do not want to know the utmost power it can be jammed up to, but what it can be comfortably worked at with reasonable economy; any purchaser ought to insist on this and see that it is covered by the contract.

It is too much in the fashion among those who have engines to sell to assume that the M. E. P. can be just about equal to boiler pressure, and to work on this basis until the engines are erected. This creates serious trouble sometimes, and sometimes too annoying misunderstanding.

I remember an instance in which an engine builder sold an engine to work at 150 horse power. He applied to me to go (the engine was 250 miles from home) and to pacify the purchaser. I examined the drawings before going, and soon satisfied myself that the engine could not work at 150 horse power with any cut-off, which was by means of an old-fashioned riding valve. I went, but consented to no trial until I had rearranged the valves. The rearrangement consisted in shifting the cut-off eccentric until the cut-off valve was inoperative, and, as was generally the case, there was but little lap given the main valve, so that the engine stood about as nearly in the condition of a full stroke engine as it could. In order to load the engine we applied, in addition to the regular work, improvised friction devices, and could get, with the steam pressure specified (90 pounds), 152 horse power, and no more.

I shifted the eccentric back, as I knew it would do its work at present with a fair cut-off, and he reluctantly gave his check. He had not got the engine he supposed he was buying, and in the course of a couple of years, when additions to the works that would call for a 500 horse power engine, planned it somehow to come to me to stand in the place of the proprietor in the purchase, but with the distinct understanding that I was not to let the party who furnished the 150 horse power bid on the 500 horse power.

My practice leads me to believe that in the instance of an automatic non-condensing engine, we may estimate on a M. E. P. of .4($\frac{4}{10}$) the boiler pressure, and if the engine is a plain slide valve, we may increase to .5($\frac{5}{10}$). I am aware this will be characterized as low by those who build engines to sell, but the obtaining of it, day by day, calls for well constructed engines, and well considered valve motion.

For example in the line of the foregoing, let the boiler pressure be 80 pounds, then I should assume the M. E. P. to be 80 × .4 = 32 pounds for an automatic engine and 80 × .5 = 40 pounds for a plain slide valve. I never believed I made a mistake in this estimating. It permitted of the M. E. P. being more than this or less, without serious loss.

As to port area, I should, under ordinary circumstances, allow .1($\frac{1}{10}$) the piston area for piston speed of 550 to 600 feet, proportionately increasing it if the speed is above 600 feet, and decreasing it if it is below 550 feet. By giving a little attention and study to these matters, the apprentice, whether in a steam engine building shop or not, may estimate the probable horse power of a steam engine with all reasonable exactness. A little here and a little there makes a mechanical engineer of the mechanic. No one will ask how the knowledge is acquired.

Colleges may subscribe to a man's right to affix M. E. to his name, but this can no more make him a mechanical engineer than you can make a horse drink when he does not want to drink.

* * *

FRICTION.

E. LAWRENZ.

When designing machines, friction must be duly considered, the bearings and faces correctly proportioned, and it will not do to either disregard it entirely or pay too much attention to it, for the consequences will be very nearly alike. Too much of a good thing will prove fatal in machinery as well as in medicine. Now, friction, in itself, must be reduced to a minimum in almost every machine built, and yet friction in each case is essential to have our machines go at all. In bicycles we have the well known ball bearings to reduce friction to the least amount. On friction clutches the surfaces of contact are not highly polished, so as to get more friction. It often happens that inventors, when designing a machine, get mixed up with friction and devise some such contrivance that will contain a superfluous amount of the very friction they seek to avoid. A peculiar instance noticed lately showed this in a marked degree. A series of discs (Fig. 1) are placed one above the other, having a common axis, are set in motion by gears fastened to a shaft. Since the velocity of any disc differs from that of all the others there evidently would be sliding friction between any two. To eliminate all friction between these discs, a genuine ball bearing was proposed to be located between them to run in concentric channels of suitable shape and dimension.

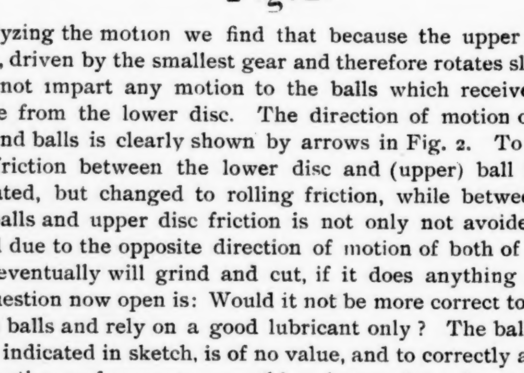


Fig. 1.

Analyzing the motion we find that because the upper disc is largest, driven by the smallest gear and therefore rotates slowest, it will not impart any motion to the balls which receive their impulse from the lower disc. The direction of motion of both discs and balls is clearly shown by arrows in Fig. 2. To begin with, friction between the lower disc and (upper) ball is not eliminated, but changed to rolling friction, while between the same balls and upper disc friction is not only not avoided, but created due to the opposite direction of motion of both of them, which eventually will grind and cut, if it does anything at all. The question now open is: Would it not be more correct to leave out the balls and rely on a good lubricant only? The ball-bearing, as indicated in sketch, is of no value, and to correctly answer the question and propose something better depends upon the work to be done, the pressure brought to bear upon the lowest and the next disc, which will have most friction, the lubricant used, and perhaps many other things which do not belong here.

Another case of friction, the remedy for which was cheaply obtained, is clearly shown by Fig. 3. It is a step bearing, in some cases the only available thing. The point here consisted in the fact that

"if a greater number of friction-discs be inserted, the friction will decrease proportionately to the number of discs used." Let us apply a little every-day arithmetic to this. According to the principle stated, if no discs be present the friction will be greatest, say unity, and for illustration's sake let us suppose that just one horse power is required to overcome friction in any given case. If one disc be introduced, friction will diminish to one-half of what it was before and therefore only one-half horse

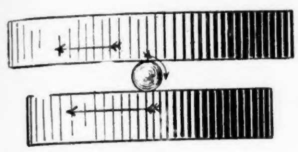


Fig. 2.

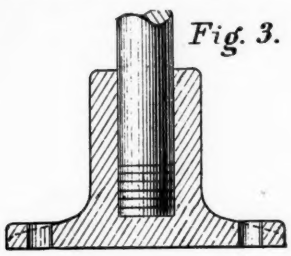


Fig. 3.

power needed. If four discs be present, friction will be reduced to one-quarter, or the power required to start the mechanism is but one-quarter horse power. Going along in this sense we can put in a million discs, when the friction and horse power will have shrunk to $\frac{1}{1\,000\,000}$, and, while we are at it, if we were to put in an infinite number of discs, friction will have vanished entirely and the friction necessary to keep the machine in motion will be zero, because 1 divided by infinity equals zero; a genuine perpetual motion. All that is necessary is to find out what infinity means, the rest is easy, as we can make the discs just as thin as we please and then pile them up in a small space. But what is the true condition of such arrangement? Friction has not been reduced, but distributed to different particles, and, therefore, the abrasion, which otherwise would take place to shaft and bearing, now will affect either all the discs, bearing and shaft included, or some particular disc alone. This always will happen with machinery of slow motion, while in those of high velocity, centrifugal force will come into play and relieve the bearing from end thrust, somewhat.

In general, sliding friction as existing between any two well finished surfaces of correctly selected material, is not the worst, and hence avoid introducing something new, something that works well and good in a given case, but whose benefit in some other instant becomes problematical. Further may be added, that friction does not depend upon the faces of contact, but solely upon weight, so that any body sliding with its largest surface upon a plate will have no more friction than when moving upon its smallest side. This principle any one can verify by simple experiments which are in reach of all and which do not require costly instruments.

* * *

CUTTING THREADS IN PIPE TAPS.

R. E. Marks.

This is usually something of a mystery to the apprentice as well as to order machinists, and a few sketches may aid in unravelling some of the snarls which this question usually gets one into. It often starts by the boy asking the man next to him whether to cut the thread of the taper tap at right angles to the taper side or at right angles to the axis or center line.

The machinist then answers that he "thought everyone knew that," and begins to wonder which is right, and the

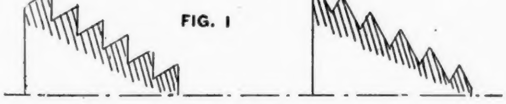


FIG. I

more he thinks the more muddled he gets. When he has the blank all turned up he naturally wants to cut a thread at right angles to the surface or side, for it is very easy to set the tool at right angles to this finished surface.

With a lathe having the taper attachment to carriage so the tail-stock does not require setting over tail-stock, it is an easy matter to set the tool at right angles to the axis if desired, as by simply taking the work out the thread gauge can be set against the lathe center and the tool set square with this and consequently square with the axis.

If, however, the tail-stock of the lathe is set over to obtain the taper, it is not altogether easy to set the tool at right angles to the axis, as will be seen later.

In Fig. 1 we have the two systems of threads, the one on the left being cut at right angles to the side of tap, the right-hand one with tool at right angles to center line or axis. In the former the threads have even sides, although it will be seen that the front or holding side of the thread has only about 30 degrees incline from the axis, reducing its holding power very materially. In the other case the thread has its holding side 60 degrees from the axis, although somewhat reduced in height, as will be seen; the thread has, however, a perfectly square pull, the same as though on a straight tap. It is probably needless to say that the tapers shown are considerably exaggerated over the usual practice, but this was done to better illustrate the difference in the threads.

Returning to the question of setting the tail-stock over, and Fig. 2 presents the case clearly in a plan view, looking down from the top, except that the artist was evidently left-handed, and has the small end of the taper next to the live spindle A; the idea is the same, however. The two threads shown at C are at right angles to the side of tap, which is shown, while those at D are at right angles to axis of A B, which is the accepted plan of the standard tap makers. This involves setting the thread tool at right angles to an imaginary line, running between the points of the two centers, which it might puzzle some to do. There is

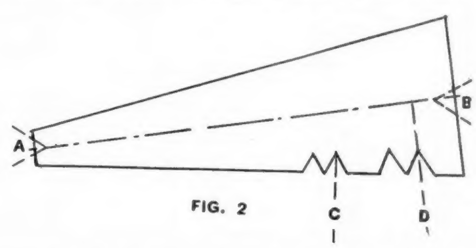


FIG. 2

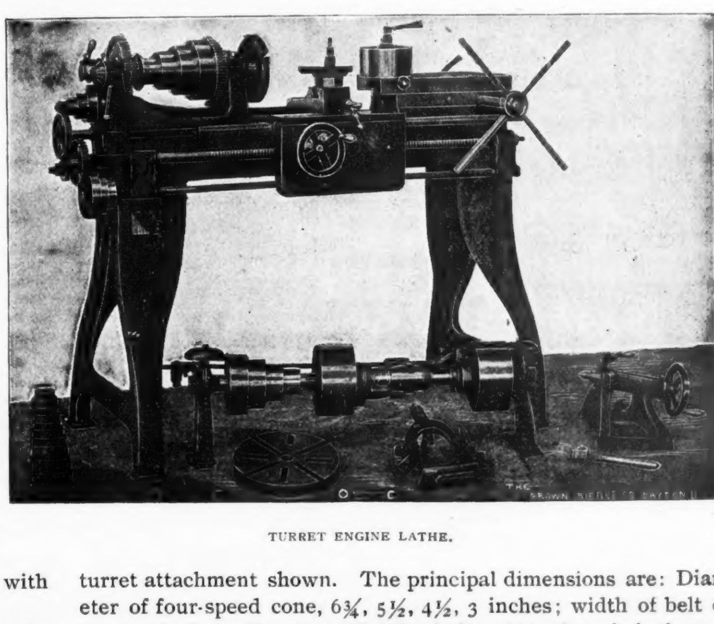
an easy way out of it, however, and that is to set the tool in line with the large end of the taper as at B, which has been squared up while turning the straight shank. By placing the thread gauge lengthwise against this and using the notch in the end for setting tool, it will be set square with the axis with very little trouble.

In actual practice, with ordinary pipe tapers (one inch in sixteen inches, or three-quarters of an inch to the foot), and especially with brass piping there is practically no difference in the pipe which way the thread is cut, and the finer the thread the less the difference. Brass threads have a wide limit of elasticity, and actually flow under strain to assume almost any shape required.

* * *

TURRET ENGINE LATHE.

The engraving shows an engine lathe with turret attachment made by the A. P. Wagner Tool Works, Sidney, O. The one shown is a 12-inch lathe, with 4½-foot bed, has screw and rod feed to carriage, same as regular engine lathe, a four-speed cone and the



TURRET ENGINE LATHE.

turret attachment shown. The principal dimensions are: Diameter of four-speed cone, 6¾, 5½, 4½, 3 inches; width of belt on cones, 2 inches; diameter of head spindle, $1\frac{1}{16}$ inches; hole through

spindle, $\frac{11}{16}$ inches; front bearing of spindle, $1\frac{11}{16}$ x $3\frac{7}{8}$ inches; back bearing of spindle, $1\frac{7}{16}$ x $2\frac{1}{2}$ inches; weight of $4\frac{1}{2}$-foot lathe for domestic shipment, about 1 050 pounds.

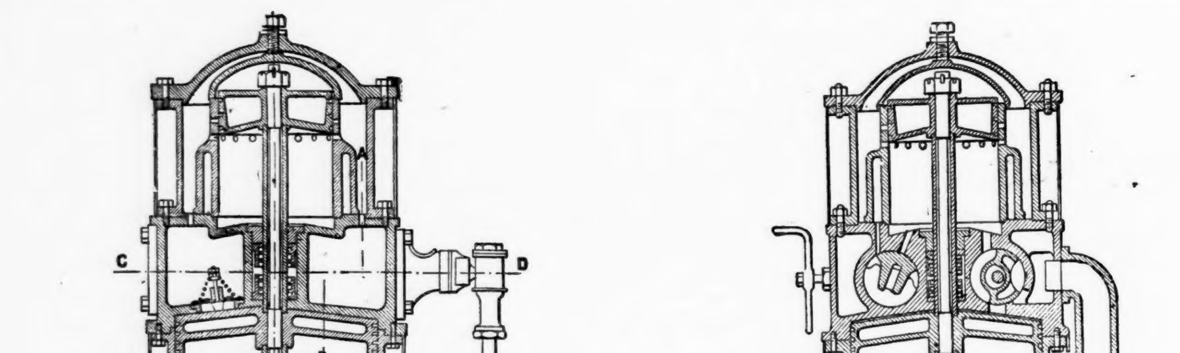
The head and tail stocks are both solid instead of cored; spindles of hammered steel, accurately ground; bearings phosphor bronze; carriage is gibbed front and back, has extra large bearings the entire length, and is accurately scraped to a bearing. The turret head is $6\frac{5}{8}$ inches in diameter, has 6 holes, either straight or Morse taper. If without bushings they are $1\frac{1}{2}$ inches diameter or $1\frac{1}{4}$ inches with case hardened bushings. The slide has a movement of 12 inches. A friction countershaft is provided, and there seems to be no reason why such a tool should not be highly appreciated in any shop.

* * *

THE UNIVERSAL HIGH-SPEED ENGINE.

A type of high-speed engine containing several novel features has quite recently been put on the market by the Brush Electrical Engineering Company Limited, of Queen Victoria Street, London from the designs of Mr. John S. Raworth. It can be made either of the simple, compound, triple, or quadruple expansion type, but the most common form is the compound, which is illustrated. In this case the high-pressure cylinder is above the low-pressure, the steam valves being placed above the latter and between the two. The high-pressure valve is distinct from the low-pressure, and the steam enters and leaves at the bottom of the cylinder. The steam from the boiler acts on the high-pressure piston during its ascent, and the steam during the descent of the piston is exhausted into a receiver, and into the low-pressure. That is to say, that up to the point of cut-off the steam already in the receiver enters the low-pressure, but when the valve cuts off, both inlets are cut off. At the top of the high-pressure cylinder there are inlets openings, which allow a portion of the expanded steam to pass into the receiver, thus equalizing the receiver pressure. The exhaust valve acts as the inlet for the low-pressure cylinder, and cuts off so as to leave a certain charge in the high-pressure to give a little compression. By reason of the relative positions of the two cylinders any water of condensation is drained out of the higher into the lower cylinder, and is finally discharged through holes in the cylinder into a lower exhaust chamber with which the exhaust valve is also connected.

The valves, which are of the Corliss type, are worked by two eccentric rods, and the high-pressure eccentric is driven by a centrifugal shaft governor, which controls the cut-off from zero to five-eighths of stroke, while the low-pressure valve cuts-off at half stroke. As was said, lubrication is a most important feature, and in this engine is entirely automatic. The crank pin is lubricated by an oil bath placed in the base. All the joints of the valve levers, and the piston rods, guides and crossheads, are continuously lubricated by means of a small double spur-wheel pump, which draws its supply from the crank pin and the cylinders by a large displacement lubricator.



THE UNIVERSAL HIGH-SPEED ENGINE.

The crosshead pin is hollow, and is an easy fit in the crosshead. It is secured in position by two conical plugs, drawn tightly together by a bolt passing through the pin. When the plugs are forced into the pin it is expanded, being split and bored conically for the purpose.

In order to get at the lower gland of the high-pressure cylinder, it is forced up by a loose frame drawn into position by two bolts fitted in the framing. It is thus possible to move the gland without twisting it and causing it to bind, and the accessibility of the nuts enables the adjustment to be easily made. The joint of the eccentric rod is simple and effective. It consists of a sphere, fitted with the spherical surfaces of two white metal pads, set up by a screw cap. The governer is simplified in detail, and altogether the engine shows signs of careful design. It is constructed generally on the lines of the ordinary crank shaft cut-off governor, but it is claimed that its action is theoretically perfect, as, with

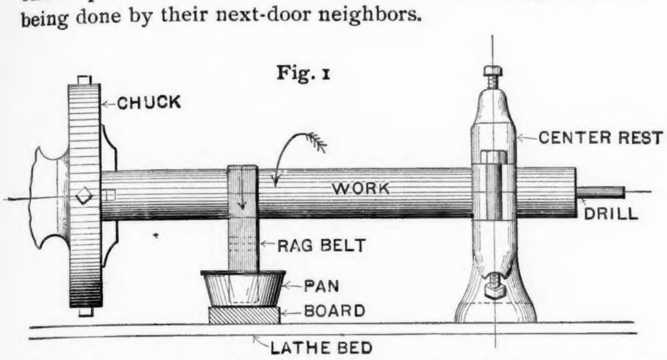
light loads, the effects on the steam is a combination of throttling with expansion. It is so satisfactory that it enables all trip gear to be dispensed with, and at the same time permits an accurate cut-off being obtained. These engines are made in several sizes up to 500 I. H. P., the piston speed varying from 415 ft. to 600 ft. per minute, the least speed being obtained in the smaller sizes. —*Practical Engineer, London.*

* * *

FOR YOUNG MACHINISTS.

MILO.

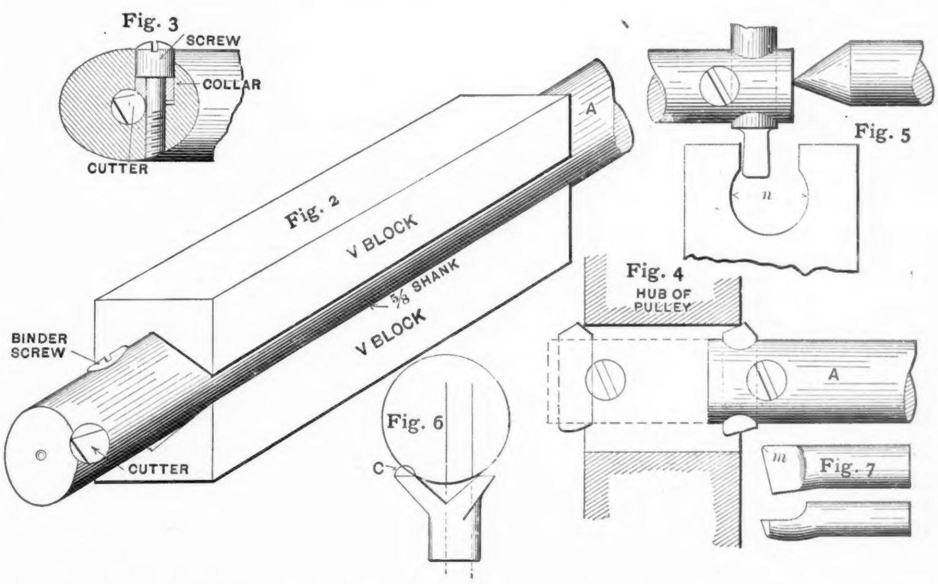
I shall not try to write something that is all new and original. What I have to offer are a few remarks and kinks that were considered too common and old by those using them to be put into print. But there are beginners all the time and they have to learn the same old tricks. I submit my mite for what it is worth, and hope that others will do the same, for it is often that men of one shop do not even know how some of the simplest jobs are being done by their next-door neighbors.



I once saw a man using an ordinary 16 inch lathe to bore out a long steel shaft. He was making a long, thin tube for a special job and used a flat drill. To prevent the work from heating, he took a pan of water and set it on a board laid across the lathe bed. Then he took a rag and folded it up into a belt about three inches wide and sewed the ends together, making an endless belt long enough to run on the shaft he was boring, and hang down almost to the bottom of the water (Fig. 1). As the work revolved, the rag ran up out of the water, over the shaft and back again; keeping the work wet and cool all the time. As the drill went deeper the pan and rag were moved along to follow it. This rig can be used on many jobs to advantage, for there is no muss about it and it is effective. A pan for this purpose, large enough to reach across the lathe bed and dispense with the board, and a good piece of burlap nine inches wide and about two feet long, would be an improvement in many shops.

BORING TOOL.

In another shop, where the motto was, "Catch all you can and hold fast to all you get," I saw a young fellow make a very handy all-around tool for his own use and he found many uses for it. Fig. 2 shows it as a boring tool. It consists of two V blocks and a shank in which cutters are held by binders. The V blocks were made as wide as the tool-post would allow, which in this case was a little more than $\frac{5}{8}$ of an inch, spring tempered and $3\frac{1}{2}$ inches long. The groove was made 90°, so that either round, square or octagon stock, could be held equally well. The thickness of the blocks in the bottom of the groove was about $\frac{5}{16}$ of an inch, and the top block was bent up a little (not enough to prevent it from being screwed down straight without breaking) so as to make it hold firm at the ends. The shank A was of soft steel $\frac{5}{8}$ of an inch in diameter and 12 inches long, in one end of which cutters could be held at right angles, while the other end held them at an angle of 60° with the axis of the shank. Each end of the shank was nicely centered in the center rest.



One-quarter inch round stock was used for cutters, which in many respects was more convenient than square, as any rake could be obtained with it in connection with the round shank and V blocks, besides being easier to make. After the holes for the cutters were drilled and reamed, the holes for the binding screws were drilled, counter-bored and tapped. Then a fluted reamer was put through the holes and revolved, while the little collars were forced down into place by the screws, to make the small notch to fit against the cutter. The little collars were then hardened (not too hard), which completed it as a boring tool, except that an additional shank was made of $\frac{1}{2}$ inch stock, but in all other respects like the one just described, to adapt it to a larger range of work. I liked it better than the patented tool used here, for it would hold any size shank from $\frac{5}{16}$ inch to $\frac{5}{8}$ inch. Besides, a tool with a rough or slightly crooked shank could be used. The binding screws were about $\frac{1}{4}$ inch with $\frac{5}{16}$ inch head, and no trouble was experienced in holding the cutters. Frequently special boring tools were forged on the end of round stock.

On one occasion the maker of this tool had a number of solid steel blanks 1 inch thick to be bored about $1\frac{1}{2}$ inches. As there was no drill or reamer of the right size, a tool like Fig. 7 was forged on the end of a $\frac{7}{16}$ inch round bar. This was put through, making a hole in the solid stock about $\frac{7}{8}$ inch in diameter at the first cut. The second cut left only enough for the finishing cut, which was made with the same tool. One side was also faced up without removing the tool, and the whole job was done quicker than if a good flat drill and side tool had been used. The point of the tool was so shaped that the edge *m* did part of the cutting preventing chatters and supporting the cutting edge. The two chips inclosed were removed from the back side of a blank in making the first two cuts*.

It will be noticed that the end of the tool is almost square, which caused it to have very little tendency to crowd sidewise away from the work, even with such a wide cutting surface, the edge *m* practically overcoming what there was, the extreme rear edge being at the exact center of the hole during the first cut. The front edge was a *little* above the center of the hole, and the shank sloped enough downward to bring the top of the cutting edge on a level or a little below the center of the shank at the tool-post, so that if the tool sprung any it would spring away from the work instead of swinging in and taking more. Larger stock for this tool would have been better, but there was none at hand and this did very well, with a plenty of good lard oil.

In chucking a large number of small pulleys it was found to be practical to true up both ends of the hole as shown in Fig. 4, by using the same tool that did the boring and running the lathe backwards, which was done before removing the pulley from the chuck. Then the tail-stock was set over and the pulleys put on the centers, one at a time, without any arbor, and a chip run half way across the face. The next operation was to turn the pulley around and run a chip across the other half of the face. By this method the pulleys were all made crowning and practically uniform and true without the usual driving of arbors and cut and try so common where driving arbors are used.

Next came a snap gauge to be made. This was done as shown in Fig. 5, because the milling machine was in use. After the

* These show a cut of over $\frac{1}{4}$ inch deep, and a good feed showing very effective work for the cutters.

hole n was drilled, the boring tool shank and cutter were put on the centers of the lathe and driven by a dog like an ordinary shaft and the snap gauge fastened on the tool-block, which was fed in the cross-feed screw. First one measuring surface and then the other was made. As there was no grinding machine in the shop the measuring surfaces were finished by hand after hardening, using a piece of copper with fine emery and oil.

To make an inside square thread tool, the shank holding the stock for the cutter was put on the centers as before. A side tool was used to square up one side, then the cutter was given a little more than half a turn, so as to make a clearance, and held while the other side was faced off in the same way. The end was turned off and the clearance filed on it. If it was desired to make the cutter thinner at the root, the tail-stock was set over to attain it. Of course the top could be turned off the same way as the sides if desired. Many cutters for special jobs can be made to advantage by this same method.

Depth gauges with the graduated measuring stem projecting from a flat polished surface are common. The measurements obtained from such a gauge are seldom satisfactory where fine work is required, unless the workman is experienced; because the line on the stem is reflected in the polished surface of the base. In such a case a line appears like half a line when only a quarter of it is exposed, and a corresponding error in the work is the result. This trouble can be helped some by giving the base surface a coat with copper solution, which I mix as follows: Put as much blue vitriol into a bottle of water as will be dissolved by it and add a little nitric acid. The acid makes it stick quicker and better and a more even color can be obtained on some metals. The solution is also better for its regular use of coating surfaces on which work is to be laid out, and the teeth of cutters, etc., while filing. It is also handy to coat the teeth of gears, drills, taps, etc., that are being set for recutting, as any newly cut surface shows plainly. For my own use I prefer a depth gauge that has a thin edge to set by, coming down close to the graduations.

A very convenient height gauge for some jobs can be made of Starrett's combination square by cutting off the corners c, Fig. 6, of the center head. It should be done accurately, for that makes it more convenient as a height gauge and permits the center head to be used on work of large diameter, as shown in Fig. 6.

* * *

BITS OF ENGINEERING.

H. Heyrodt.

The importance of a little knowledge of chemistry to the engineer is very often underrated and the study of this science almost entirely neglected by the average engine runner. A most instructive illustration of the effect of neglecting chemical principles I witnessed some years ago, when visiting an engineer friend. In the establishment where he was employed they used superheated steam of 1 200° Fahr. The superheating apparatus consisted of a spiral coil of 2 inch pipe, set into a furnace. It happened that through some accident the lower pipe burst open for about 4 inches. Being in great hurry to start up again, they tried to patch the split by bolting a piece of sheet iron against the pipe, filling in with red lead. After the joint got hard, steam was turned on and everything was apparently all right. Not long after the fire was started the joint blew out again. So they tried it again, adding another clamp to squeeze the sheet iron up. The same result. I just happened in at that time and John complained about his misfortune and told me that he would try litharge next, as that would harden instantly. I listened for a while, then seeing a cracked elbow on the floor, I picked it up and asked for a little red lead and litharge. We put some of each in separate pieces of the elbow and put these into a boiler furnace. When they were red hot I took them out, and you ought to have seen John's face. All he found in our improvised crucibles was a little ashes and common molten lead.

Red lead (Pb_3O_4) and litharge (PbO), oxides of lead, have about the same melting point as lead, 612° Fahr. The temperature of the steam was 1 200° Fahr., hence the failure. A piece of asbestos paper made a satisfactory patch. A little chemistry will also help in selecting and testing lubricating oils, and the following points may be useful to some. I speak here of hydro-carbon or mineral oils. The color of the oil should be perfectly clear, as cloudiness indicates the presence of water or excess of paraffine. When treated with an alkali it should not saponify. If it does, it is mixed with animal fats. To detect acid or alkali, wash a sample of oil with distilled water. Draw off the water and add to it a few drops of phenopthalein; if it turns a red color, the presence of alkali is indicated. If a piece of litmus paper, dipped into the water, changes color, it is a sign of acidity. Next take a sample and add a little sulphuric acid, which should give a yellowish brown color only. Should it darken or blacken the oil, or increase the temperature considerably, it indicates a low grade oil, mixed with resin and fat oils. Exposed to a temperature of 200° Fahr. it should not lose weight.

* * *

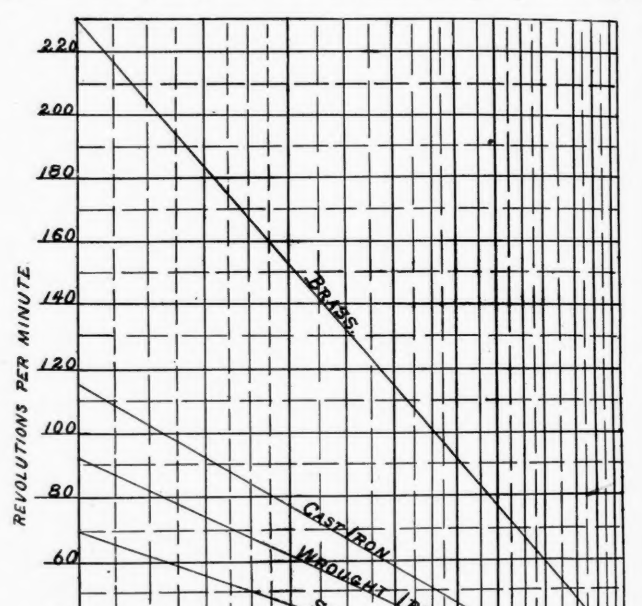
We have received a very interesting set of 50 cards containing half-tones of the prominent portions of Barcelona, Spain, from Manuel Mirel & Sons of that city.

* * *

SPEED OF MILLING CUTTERS.

There is a marked difference in mechanics regarding the way in which they like to receive information on any subject, in much the same manner as they oung lady who said she always traded at Matchem's Pharmacy, because he used pink string to tie up his bundles, and pink just matched her complexion. So with data concerning machine tools. Some like formulas; some long winded rules that they mumble over for a month trying to memorize, and then usually forget the important part; others like tables with rows and columns of figures to follow to find the desired information. These are all the pink strings that match the mental complexion of the various men.

There is still another kind: the chap who likes to see things at a glance and who naturally turns to graphics, by making a mark an inch long and saying: "That represents 100 revolutions, or pounds, or anything else; this 1½ inches long represents 150 of



the same thing, and I can guess pretty close in between," and he makes his chart or diagram which shows what he wants, with scarcely a figure in it.

This was the case with the originator of the accompanying diagram, which was taken from the *Practical Engineers' Pocket Book*, so that it evidently represents English practice in this line of work.

According to this, if we have a milling cutter 4½ inches in diameter and we wish to run it on steel, we find the line marked 4½ on lower line and follow the line up till it reaches the line marked "steel," then following the horizontal line to the left we find 30 as the number of revolutions per minute, because the line comes midway between 20 and 40. If the intersection of lines does not come exactly on a horizontal line, follow the nearest line and estimate the distance to be allowed either above or below. How does this compare with your experience ?

MACHINE SHOP ARITHMETIC.

A series of practical articles clearly explaining the portions of mathematics which will be useful to the men in the shop and engine room.

PRACTICAL QUESTIONS CONNECTED WITH THIS SUBJECT WILL RECEIVE PROMPT ATTENTION.

PROPORTION.—2.

W. L. CHENEY.

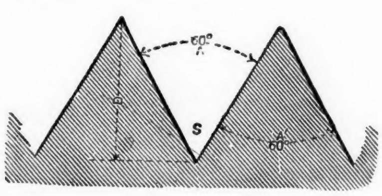
The subject of proportion was considered in the June number, and some examples relating to speeds of pulleys, etc., given; but, as hinted in June, its use is not by any means confined to the examples shown.

It is proved by geometry that *triangles* are *proportional;* that is, in similar triangles (in which the angles are the same) if one side is, for instance, twice as long in one triangle as in the other, that the other two sides will also be twice as long, or if one side of one triangle is half as long as in another, the other two sides will also be half as long.

One very useful way of using this in practice is in calculating the depth of threads of screws. Of course it is hardly necessary to say that the ordinary V thread of a screw, or tap or die, is in the form of an equilateral triangle (all three angles *equal,* or alike), each angle being 60 degrees (see cut).

Assume the cut to be *one thread to the inch,* and it is found by geometry and square root that the depth of the thread—D, of the cut, corresponding to the *height* of the triangle, is .8660 (see note).

It follows then, by proportion, that in a screw, or tap, or die, of two threads to the inch, that all parts of the triangle will be one-half as great as if the threads were one to the inch and that the depth corresponding to the height of the triangle will also be half as great. And if three threads to the inch everything will be one-third as great, and so on.



We need, therefore, figure out only once for all the depth of a thread which is one to the inch, and divide the result by the number of threads to the inch, to get the depth of any thread.

Therefore, to find the depth of any V thread, divide .8660 by the number of threads to the inch.

Example.—What is the depth of a V thread which is 16 to the inch?

$$.8660 \div 16 = .0541.$$

Thus: The square of $1 = 1$; the square of $\frac{1}{2} = \frac{1}{4}$. $1 - \frac{1}{4} = \frac{3}{4}$ and the square root of $\frac{3}{4} = .8660$, the height required.

There are various practical uses for this in the shop. For instance, if necessary to bore a hole in which a thread is to be chased, as often happens on odd jobs for which there is no tap. The diameter of the hole must evidently be twice the depth of the thread less than the outside diameter of the screw to which the chased nut is to be fitted, and as it is almost always used for some such purpose as this, it is better to multiply the .8660 at once by 2, which gives us the "constant" 1.7320 to be divided by the number of threads per inch.

Example.—What size must a hole be bored to chase 16 threads per inch for a screw 1 inch diameter?

$1.7320 \div 16 = .1082$ and $1 - .1082 = .8918$, the diameter of hole required (practically the hole should be bored a little larger for clearance).

Having arrived at the principle of the matter, we can now consider "United States Standard" threads (so called), which, instead of being sharp at top and bottom, are "flatted one-eighth" at top and bottom, making the depth *proportionately* less, so that the constant would be 1.2990 (this being *one quarter* less than 1.7320: one-eighth for the "flat" taken off the top of thread, and one-eighth for the flat "filled in" at the bottom, and as this shape of thread is now mostly used, the constant 1.2990 therefore is the most useful).

It is a good thing to make United States Standard taps (of not too large diameter) enough *oversize* to bring the tops of the threads to a sharp point, so that the screw used in the nut will have clearance (and the screw should be cut *sharp* at the *bottom* for the same relative reason); we can then use this same idea to find out what size to turn oversize taps for any thread, by first calculating the height of the small triangle added to the top of the United States standard thread to bring it up sharp, which having been found (by exactly the same process as before) and muliplied by 2, gives us the constant .2165 to be divided by the number of threads and added to the nominal diameter of the tap.

Example.—What size must a tap 1 inch, 16 threads United States Standard be turned to bring the threads sharp on top for clearance?

$.2165 \div 16 = .0135$ and $1 + .0135 = 1.0135$ the diameter required.

* * *

ONE KIND OF SHOP KINKS.

T. HEAD.

We do not run a "job shop," but every machine shop must of necessity be more or less of a job shop, and if you happen to be blessed with a fair stock of good tools you are also sure to be blessed with a proportionate number of borrowers.

We of course expect to lend our tools; we always have and probably always will until they wear out and we are too poor to buy new ones, but we hope to always have good ones (to lend), for we very often get quite a little amusement from lending, and it helps us to understand human nature and also to get acquainted with all of our neighbors, and the amusement we get out of it of course makes our grief easier to bear when we have a brand new reamer or tap brought back with pieces broken out all along the teeth, and the journeyman (?) tells us that "It was just that way when he got it."

The other day one of the journeymen (?) from an adjoining shop came in to borrow a tap; said he wanted "a large ⅞ inch." One of our men who had just finished using the large ⅞ inch tap handed it over to our neighbor, and he departed whistling "God Save the Queen," and with a happy smile on his face. In about ten minutes he came back looking very much troubled, and remarked as he laid the tap down on the bench before the man of whom he borrowed it, "Just a hair too small; you don't happen to have one just a little bigger, do you?" Our man told him that it was the best one we had, and remarked, by way of a joke, "If it is only a little too small, why don't you twist a little waste around it. The journeyman (?) brightened up and off he went with the tap again, but came back after a few minutes, and remarked as he pulled the waste out of the teeth of the tap, "That don't seem to help it any, for it won't cut quite big enough even with the waste on." Our man tried to keep his face straight until after the journeyman (?) had gone, but he found it impossible just at that time to offer any further suggestions to assist his fellow workman in tapping that hole just a little bigger; so he

NOTE.—An understanding of the chapter on "Square Root" published in this paper in October, 1895, will easily allow the student to calculate this height .8660 as follows:

The line D of the cut divides the equilateral triangle into two right-angled triangles; as each side of the equilateral triangle we know to be 1 (inch) the side cut in two by the line D makes the shortest side of the right-angled triangle ½ (inch). The longest side of right-angle triangle is the hypothenuse, which we know to be equal to the sum of the squares of the other two sides. If we then subtract the square of the side which we know to be ¼ (inch) from the square of the hypothenuse, which we know to be 1 (inch), we shall evidently have remaining the square of the other side.

left, probably to look for somebody who could lend him a "large ⅞ inch tap."

* * *

HOW AND WHY.

A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

64. J. Y. M. wants to know why the threads of the bolt do not exactly correspond with the pitch of the die. *A.* From our point of view it is caused by the die not being fed on to the work at a uniform rate; in other words by its being held back slightly owing to the work it does in pulling the carriage with it. In machines where the die is fed by a screw, this is overcome.

65. G. H. P. asks: Suppose the high pressure crank-pin of a compound engine was to break, what could be done to get into port? Could the engine be worked low pressure, and if so how could it be worked? What pressure would it be safe to carry? The cranks are at 90°. *A.* There should be no trouble in getting into port with the low pressure cylinder; just exactly what should be done in the way of preparation will depend upon the construction of the engine, and upon general conditions. The first engineer, if a competent man, as he generally is, will decide very quickly. Perhaps chocking the cross-head so as to hold the piston at one end of the cylinder and removing the valve of the disabled engine may be all that is necessary, except clearing away the disabled parts. The steam from the boilers will then pass freely through the high pressure cylinder to the receiver. As to safe pressure to use in the low pressure cylinder, that will depend on the strength of parts. Manifestly there will be no added danger from admitting steam to the low pressure cylinder at a pressure as high as the usual receiver pressure, perhaps considerably higher, but an engineer with his high pressure engine disabled is not disposed to take much risk with the low pressure engine. The exercising of the reasoning powers and a careful watch to the end that from any cause steam does not find its way into the cylinder at sufficiently high pressure to break down the low pressure engine, will cover the requirements.

66. H. M. G. asks: Does it pay a young man to attend a mechanical school after he has completed an apprenticeship of four years in the machine shop? *A.* Decidedly yes, if one can devote the time and money. We think it far better to go to school after an apprenticeship rather than before, as the shop practice shows him the practical side of questions and the subjects that are most likely to be needed in after life. 2. What are the best mechanical schools? *A.* We do not care to make a choice. For you, we should recommend Cornell, as being in your section of the country. 3. Not having money enough to go through college with, what would you suggest? *A.* We should advise a course in one of the good correspondence schools; some of the best are advertised in this paper.

67. R. E. C. asks: What is the advantage in using water in turning wrought iron? *A.* There are several advantages. It keeps the tool cooler than it would be without it, and helps to prevent drawing the temper, and it leaves a nice finish on the work. The disadvantage of rusting the work and lathe, unless they are wiped carefully, can be avoided by using sal soda (washing soda) in the water.

68. D. N. asks if there is any rule for calculating the difference in the diameter of steps of cone pulleys? *A.* This was made very clear in an article by W. L. Cheney in the issue of April, 1895.

69. H. K. L. asks about the thickness of hydraulic cylinders. *A.* See last month's paper on pages 320 and 321 and the article on Thick Cylinders by F. F. Hemenway on the first page of this issue.

70. S. R. A. asks: 1. Is there much actual fuel going to waste in the smoke poured forth by some of our power stations? *A.* Very little, in fact not worth saving so far as the fuel goes; the question is the effect on surrounding houses and neighborhood. 2. Is is practical to "burn smoke." *A.* No. It can be *prevented* to a large extent by careful firing and by various devices for admitting the right quantity of air. Many mechanical stokers practically prevent smoke, but once it is made, it becomes a much more difficult matter. 3. Is it economical to prevent smoke? *A.* Unfortunately it does not seem to be so. In some parts of England, where the "anti-smoke laws" have been enforced to a large extent, several large manufacturers, after trying several devices, threw them out and declared it cheaper to pay the fines than prevent the smoke.

* * *

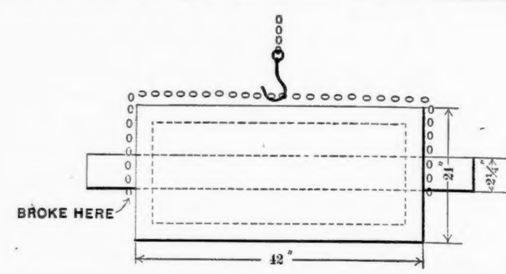
WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

WHAT BROKE THE SHAFT?

Some little time ago a peculiar accident happened in the shop to a piece as shown in sketch. It was a large cylindrical shell of cast iron, with a 2¼ inch wrought iron shaft through it, and it had to be "skimmed" up in the lathe. It was finished and was



being taken out of the lathe when one end of the shaft broke off close to casting.

What in your opinion was the cause of the break, as there was not the least sign of a flaw in the shaft? Do you think if the chain sling had been longer the shaft would have broken? The sling had to be as short as possible on account of lack of room over lathe. Cast iron shell was about 3 inches thick. W. D.

WELDING CAST IRON.

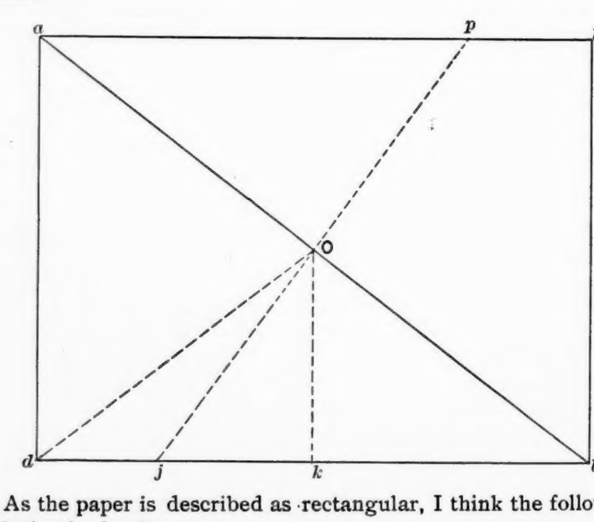
Would you kindly tell me where I could purchase a material called refined solton? I have an old receipt for welding cast iron to cast iron, which consists of the following: Take of good clear white sand, 3 parts; refined solton, 1 part; fosterine, 1 part; rock salt, 1 part. Mix it all together, take two pieces of cast-iron, heat them in a moderate charcoal fire, occasionally taking them out while heating and dipping them into the mixture until they are of a proper heat to weld. Then lay them on the anvil and gently hammer them together.

I can purchase everything but the part called solton. Would you kindly put this before your readers and perhaps some one may have heard of this receipt and can inform me where to get this ingredient so that I can make use of the formula.

Indianapolis, Ind. FRED G. EMMELMANN.

ANOTHER SOLUTION.

On page 281 of your issue for May is an answer to N. S. D. for finding the distance from crease to end of a rectangular piece of paper which has been folded over on itself so that opposite corners meet.



As the paper is described as rectangular, I think the following solution is simple:

Taking the rectangle to be, for convenience, 3 inches wide and 4 inches long, drop from *o* the perpendicular *o k* to the base line

$d\,b$ at its middle point. Now $j\,o\,b$ is a right angled triangle as is $o\,k\,b$ and $o\,k\,j$, and they are similar therefore, their homologous sides are in proportion. Hence:

$k\,b$ the base of triangle $o\,k\,b$.
: $o\,k$ the base of triangle $o\,k\,j$.
:: $o\,k$ the side of triangle $o\,k\,b$.
: $k\,j$ the side of triangle $o\,k\,j$.

$k\,b$ being one-half of the base or 2 inches, and $o\,k$ one-half the height or $1\frac{1}{2}$ inch, the proportion becomes:

$$2 \text{ in.} : 1\tfrac{1}{2} \text{ in.} :: 1\tfrac{1}{2} \text{ in.} : k\,j \text{ or } k\,j = 1\tfrac{1}{8} \text{ inches.}$$
$$2\,k\,j = 2\tfrac{1}{4} \text{ inches.}$$
$$d\,j = d\,k - 1\tfrac{1}{8} \text{ in. or } \tfrac{7}{8} \text{ distance required.}$$

Corning, N. Y. FRED E. ROGERS.

TETRANGLE AND OTHER TOOLS.

I send circulars which will give the desired information regarding my patented tetrangle and also of my double triangle and my scale of proportional inches. I also enclose a paper of mine on gear wheels, which may be of interest to you in connection with articles on that subject recently in your journal.

Either the "tetrangle" or the "double triangle with 75°" can be more conveniently used for any work that can be done with the 45° x 45° and the 30° x 60° triangles used separably *or combined*. The tetrangle was patented first, as it is less expensive to make and buy, but as many people thought it objectionable to have to draw 45° lines underneath an edge (I do not myself), the double triangle, though an earlier invention, was patented later, and has been perfectly satisfactory to the many who have used it. The tetrangle *has* the slight disadvantage (also possessed by the expensive triangle described by Mr. Smith and illustrated as Fig. 2 in his article on "Handy Drafting Tools" in your March issue), that the 45° edge is the shortest. By using the double-triangle with one of its shortest edges against the T-square, one of the long sides of right angle can be used for plotting 30°, 45° and 60°, while the inside edge for 15° and 75° is almost as long.

The outline of the "tet angle" illustrated in your May issue is not as well proportioned as the "tetrangle," and as the latter instrument is probably meant, will you please correct the mistakes in its shape and name, and the inventor to whom it is credited.

The scale of proportional inches will be found of better shape (less likely to slip, and never having to be turned lengthwise) than the one described in Mr. Smith's article, and the graduations are the most convenient for the preparation of drawings with sizes expressed in inches. L. F. RONDINELLA.

Philadelphia, Pa.

[The cut in the following letter on this page illustrates a double triangle, but not the one mentioned by Mr. Rondinella.—EDITOR.]

TETRANGLES AGAIN.

Herewith are a few sketches of a tetrangle which I have used for $4\frac{1}{2}$ years, and which combines the two standard triangles in one. Fig. 2 shows the method of using it for 30°, 60° and 45°.

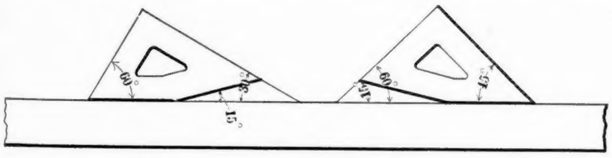


Fig. 2

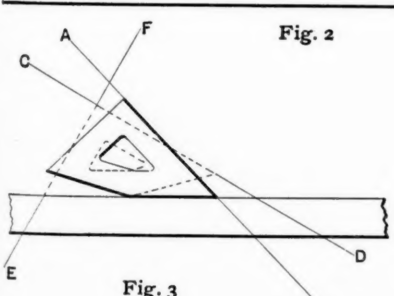


Fig. 3

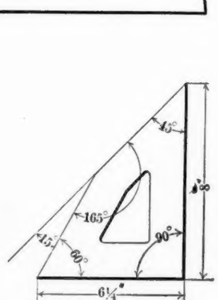


Fig. 1

You get these angles on top towards the light and on the long edges, and the 45° may be drawn in two directions without moving the tetrangle.

To draw a line at an angle of 15° or 75° to another line as A B, move tee square and tetrangles into positions shown by full lines in Fig. 3, then shift to positions shown by dotted lines, giving C D at 15° and E F at 75°. This tetrangle does not give these two angles as easily as the one you illustrate, but they are not used as much as the 45°. F. W. SEIDENSTICKER.

Chicago, Ill.

GOOD, IF IT WERE ONLY CORRECT.

In the solution of question 53, page 281, you lug in trigonometry. This reminds me of Sir Hudibras, who could

"Resolve by sines and tangents straight
If bread or butter 's wanting weight,
And wisely tell what hour o' the day
The clock doth strike by algebra."

The following formula is much more simple:

$$\frac{\text{Length} - \text{width}}{2} + \frac{\text{width}}{\text{length}}.$$

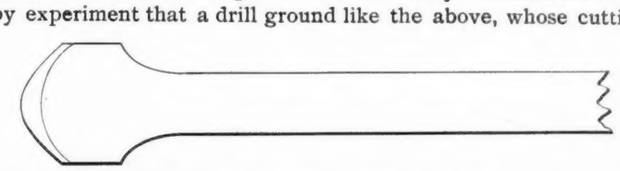
If the paper is 4 inches by 6 inches, the end of the crease will be $1\frac{2}{3}$ inches from the corner. C. W. SHEDD.

Columbus, Miss.

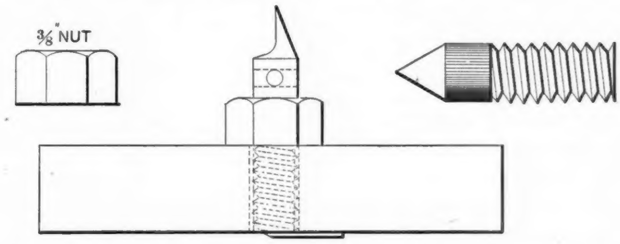
[We did not use trigonometry unnecessarily, for while the simple formula works in the instance cited, it will not in many cases, and therefore is not applicable for general use. Our object in going into the subject in detail was to show the inquirer how each step was performed. Will Mr. Shedd tell us how he deduced the formula ?—EDITOR.]

SELF-CENTERING CHUCKING DRILL.

Any one who has tried to center a flat chucking drill knows how difficult it is at times to get it started centrally. It has been found by experiment that a drill ground like the above, whose cutting



edges are ground to the arc or arcs of a circle will find the center automatically. The drill is supported by the rest as usual, but not rigidly; it being necessary only to prevent the drill from turning. This countersink is intended to be used where countersinking cannot be done by other than hand power. The countersink may be made of a piece of either round or square steel. If round steel holes must be drilled as shown, so as to turn it by means of a lever. A wrench may be used on square steel. The nut is for feeding the tool to the work, a thread being cut on the



countersink as shown. The block through which the countersink passes may be made of any convenient size and material. Tools for other purposes may be used in the same block. Other applications of this method will suggest themselves.

* * *

MANUFACTURERS' NOTES.

MESSRS. WEIS & LESH, the well-known manufacturers of Jackson, Tenn., recently about doubled the capacity of their plant and, paradoxical as it may seem, did it by reducing the number of their machines or, more properly speaking, by replacing their equipment of twelve lathes, which have been running five years, with seven of the Egan Co.'s new and improved automatic lathes.

With these lathes, owing to the many improvements embodied in them, Messrs. Weis & Lesh are, as stated, enabled to nearly double the capacity of the plant, and to better advantage than had the old lathes been retained and new ones added.

THE PENBERTHY INJECTOR CO., Detroit, Mich., sent us an invitation to attend the celebration of the manufacture of their 100,000th Penberthy injector, on July 25th, which we regret having been unable to attend. As the first one was made on June 5th, 1886; this shows a remarkable production and sale, and one which has hardly been equalled by any other makers. The company chartered the steamer "*Sappho*" and gave their employees and visitors a holiday and excursion to "Beauvoir" on the St. Clair River.

THE HAZELTON BOILER COMPANY, New York City, report recent sales of boilers aggregating 2,450 HP. They have also recently completed contracts with the Capewell Horse Nail Co., Hartford, Conn., and Messrs. P. & F. Corbin, New Britain, Conn. The Hazelton Company

reports that nearly all of their orders now being received are for the very earliest possible delivery, and that many of their recent sales have been made to old customers who are now enlarging their plants.

THE ENTERPRISE BRASS MANUFACTURING Co., of Louisville, Ky., has just been reorganized with H. Conrad as President. New capital has been added and they propose to increase their capacity. New machinery has been purchased of the Davis & Egan Machine Tool Co., of Cincinnati, Ohio.

THE longest span cableway in the world is that put in something over a year ago for the construction of the Holyoke Dam, Holyoke, Mass. It has a length of 1,550 feet. The longest span cableway previously erected was one of 1,505 feet, at Point Pleasant, West Virginia. The Holyoke cableway has recently been re-modelled by the Lidgerwood Mfg. Co., putting in a new Lidgerwood carriage and the Miller patent fall rope carriers. The original contractors for the cableway used a Lidgerwood engine, hence the plant as it is installed to-day, is practically the same as the ordinary Lidgerwood cableway. The head tower is 125 feet high; the load carried, six tons.

ON the 10th of July the Bickford Drill and Tool Company moved temporarily to the corner of Front and Lawrence Streets, Cincinnati, Ohio, and the new building which they are putting up is in active progress at their old site, corner of Front and Pike Streets. The building will be 75 feet wide, 125 feet deep, four stories high, with necessary provisions and arrangements for a more perfect production of their machine tools.

* * *

WHEN our Western readers visit the East we advise them to try the Providence Line between New York and Providence. The boats of this line leave at a comfortable hour in the evening and land their passengers in Providence at an equally comfortable hour in the morning. The latter city is probably as convenient a center from which to reach any New England point as can be named, being about an hour's ride from Boston and Worcester, and relatively as near other important manufacturing centers. Providence itself is well worth a day of any mechanic's time, as it contains a half dozen shops whose inspection will well repay the time devoted. The return trip down the Narragansett Bay is one of the most delightful evening sails that can be found on the Atlantic coast, and during the summer months the cottages and hotels along the water salute the steamer by burning red fire, which furnishes a series of weird but attractive pictures of the surrounding shore.

* * *

FRESH FROM THE PRESS.

Something About X-Rays for Everybody. Edward Trevert, Bubier Publishing Co., Lynn, Mass. Paper Covers. 78 pages. 25 cents.

This is a thoroughly popular work, compiled from the various electrical journals and will probably find a wide sale, as the subject is just now very fresh in the popular mind. Some of the illustrations are excellent while others are of the newspaper variety; but the book contains much information that the public and amateurs will appreciate and easily worth more than its price to those interested.

The Wisconsin Engineer. Vol. I. No. 1. University of Wisconsin *Engineering Journal*, Madison, Wis. 160 pages, 6¾ x 9¾ inches.

This contains considerable information on the different branches taught in the university and includes civil engineering, storage batteries, a theory concerning energy in hydraulics. Road making, subways for electric wires, data on stadia measurements, centrifugal cream separators, structural iron and steel also find a place in its pages, together with several other interesting articles on various engineering topics. The only adverse criticism would be in the adoption of a size which is not standard.

The Living Topics Cyclopedia. John B. Alden, 10 Vandewater street, New York.

We have received another section of this interesting work which deals with live topics (which are really the ones we are interested in) in a clear, concise and interesting manner. The present volume takes one from John Merle Coulter, the botanist, to Guatamala. It is decidedly interesting, and specimen pages can be had for the asking.

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ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9X12, 6X9 AND 3½X6 INCHES. THE 6X9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

WE have been favored by Secretary S. T. Johnston with a copy of the By-Laws of the Western Foundrymen's Association. This seems to be a very wide-awake association, and much information is brought out at their monthly meetings.

THE MOSSBERG MFG. Co., Attleboro, Mass., have issued a small catalog showing the construction and telling the merits of their roller bearings. It contains some very flattering testimonials from those using the bearings and will interest all users of machinery.

THE STANDARD AIR BRAKE Co., 100 Broadway, New York Catalog. 34 pages, 9x12 inches.

This is one of the neatest catalogs we have seen, and the arguments in favor of the adoption of the air brakes for street railways are conclusive to any one willing to be convinced—which doesn't seem to include some of the street railway managements. It is to be commended to the attention of those dealing with cars which are not so equipped.

WATERTOWN STEAM ENGINE Co., Watertown, New York. Catalog of Direct Connected High Speed Engines. 24 pages.

A useful catalog, showing by fine half-tone illustrations the manner of connecting the leading makes of electric generators direct to their engines—both horizontal and vertical as well as simple and compound.

THE BIGNALL & KEELER Co., Edwardsville, Ill. Catalog 13 of the Peerless and Duplex Pipe Threading and Cutting Machines. 106 pages.

This is a handy little catalog, showing their various kinds of pipe tools, emery surfacer, rachet drills, dies, chucks and similar tools. It also contains a number of pages of useful data and other information concerning pipe; its strength, weight, flanges, etc., etc., which will make it valuable to any mechanic. Copies will be sent on application.

WHITCOMB MFG. Co., Worcester, Mass. Catalog.

This shows the planers, hand and power punches, boiler plate rolls and shears in regulation style, calling attention to the special features in a few words but showing no detail illustrations. Knowing some of the good points of these tools, we believe it would be better to call particular attention to these features.

SPRINGFIELD MACHINE TOOL Co., Springfield, Ohio. Booklet of Machine Tools.

Under the heading of "Money Savers for your Shop," there is more information to be found concerning the tools made by this firm and their strong points than is usually found in a complete catalog. It is interesting reading and is almost sure to be preserved for reference.

THE A. P. WAGNER TOOL WORKS, Sidney, Ohio. Catalogs of Machine Tools.

These are convenient in form, brief in description; calling attention to the special features of the machines in English, German, Spanish and French, and illustrating the tools with half-tone cuts. Several interior views are shown of different departments of their shop, and illustrating their claims to rigid inspection, the use of special tools for insuring accurate and interchangeable work at low cost; in short, a modern plant.

THE WATERBURY FARREL FOUNDRY, Waterbury, Conn.

This company have just issued a circular devoted to "Bicycle Machinery," which contains small cuts and brief descriptions of tools made by them which are especially valuable to bicycle makers. This includes draw benches, reducing presses, swaging machines, spoke threaders, chain machines and various presses for different kinds of work. Full descriptions will be sent on application.

ROLLINS ENGINE Co., Nashua, N. H.

With the title of "A Handful of Trumps," this company has issued one of the neatest little booklets in this line that we have seen. Several indicator cards are shown which will interest engineers, as they are certainly diagrams that any company can be proud of. These were taken in various plants and are accompanied by favorable letters from the firms using the engines.

STEWART HEATER Co., Buffalo, N. Y. Catalog of Heaters. 48 pages.

A complete catalog, showing the various forms of the Otis heaters and their advantages. Special stress is laid on the use of smooth tubes instead of corrugated, as it is claimed the corrugation forms a shelf to retain the sediment. There is much information to be had from this catalog and every engineer should obtain a copy.

A LITTLE book with the title "New York as a Summer Resort," has just been issued by the Passenger Department of the New York Central as No. 19 of its popular "Four-Track Series." Its pages reveal the fact that New York is not only one of the world's greatest cities, but that it is in all essentials the greatest summer resort in the world. No other resort has such amusement palaces, such hotels, such facilities for boating, bathing and fishing, such a variety of features for the entertainment and care of Summer visitors.

A copy of "New York as a Summer Resort" will be sent free, postpaid, to any address, on receipt of two 2-cent stamps by George H. Daniels, General Passenger Agent, Grand Central Station, New York.

ARMSTRONG MFG. Co., Bridgeport, Conn., and 139 Center street, New York. Catalog.

The Armstrong pipe tools need little introduction, their adjustable stocks and dies for pipe and bolts, their machines for cutting and threading pipe and their vises for pipe fitters and others. The nipple holders and brass pipe holders will prove a boon to workers in these lines. They are also listing lathe dogs, clamps, etc.

L. S. STARRETT Co., Box 91, Athol, Mass. Catalog.

That this branch of the business of the Starrett Co. has grown to large proportions is shown by the catalog of cutters, containing 23 styles and over 400 sizes. Those interested should not fail to get one.

THE NATIONAL CHUCK CO., 39 Cortlandt street, New York. Catalog No. 24.

A 48 page catalog, showing the different varieties of chucks and what may be called shop appliances. The National Chuck is well-known and needs no introduction. The Errington tapping attachment is also shown and will interest any one having much tapping to do. It is fully automatic and will soon pay for itself in any shop.

OTTO GOETZ, 114 Broad street, New York. Pamphlet of Testimonials of Mannocitin.

This is an attractive little booklet, and the testimonials are about as convincing and as favorable to Mannocitin as could well be devised. This rust preventative is highly endorsed by such firms as Pratt & Whitney, Cleveland Twist Drill Co., Billings & Spencer and many others of equal prominence. It seems to have enough good qualities to warrant any one interested in investigating its merits.

"*Suburban Houses North of the Harlem River*" is the title of No. 4 of the Four-Track Series for 1896. This is a folder of many pages, giving illustrations and descriptions of the many desirable suburban places within easy reach of New York. Cities are becoming more and more places for business solely, while the outskirts are becoming the sleeping abode of thousands. All this is made possible by the service of such roads as the New York Central. A large colored map, 16x40 inches, of the locality described, is on one side of the folder, and adds greatly to its value. It can be obtained by sending two 2-cent stamps to George H. Daniels, Grand Central Station, New York.

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GRAPHITE, which is one of the forms of carbon, and more generally known as plumbago or black lead, has come to be an important factor in electrical industries. It is a graphite crucible which is used for electrical smelting, and it is a graphite pencil or rod which is used as an electrode in the process of electrical smelting. It is graphite pulverized to an impalpable powder that is used in electrolytic work by the copper smelters. Pure flake graphite is also used for lubricating cylinders and bearings of engines and dynamos, and the same material also forms the pigment for protective paints for trolley poles, electric light poles, and roofs of dynamo plants and trolley car sheds. Graphite would therefore seem to be a very important factor in electrical industries. During the last year or two the demand has very greatly increased for graphite resistance rods. Unlike German silver, it is not necessary to take into account the factor of quantity. For instance, a six inch rod one-fourth inch in diameter may be made to have one ohm resistance or 10 ohms, or 1,000 ohms, or in fact almost any resistance that the electrician may require. The only reason for changing the dimensions of such rods would be either convenience or for radiating the heat when it is necessary to carry a current of considerable quantity at high resistance. The Joseph Dixon Crucible Company of Jersey City, N. J., which was the originator of the graphite industry, and is now the most extensive miner, manufacturer and importer of graphite, has paid particular attention to the requirements of electrical engineers and is supplying the electrical industries with large quantities of material.

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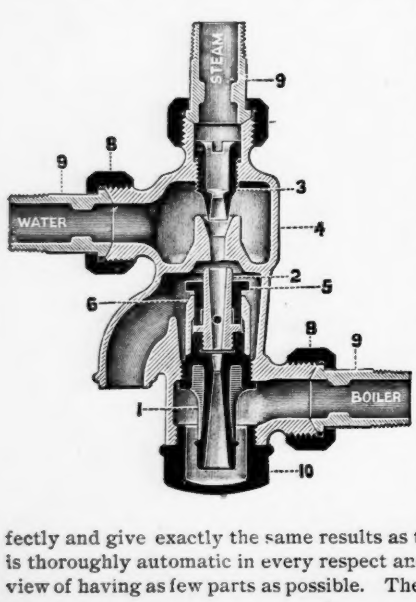
NEW AUTOMATIC RESTARTING INJECTOR.

We show herewith a cut giving a sectional view of the new Automatic Restarting Injector lately brought out by Wm. Sellers & Co., Inc., of Philadelphia, and for which Jenkins Bros., 71 John Street, New York, have been appointed their Selling Agents. It was designed for use on stationary and portable boilers, traction and hoisting engines, tug boats, etc. It is the result of many years of careful and scientific study and experiment to determine the proportions and shapes that will give the widest possible range, with the most economical consumption of steam and the same time be perfectly reliable. Their system of manufacture is such that the pipe sizes and proportions having once been determined, they are strictly maintained by having parts made to a perfect system of gauges, so that they are thoroughly interchangeable and, although this injector may have been in service until quite well worn, a new tube or part can be furnished that will fit perfectly and give exactly the same results as the original. This injector is thoroughly automatic in every respect and has been designed with a view of having as few parts as possible. There are no levers, no fittings except ordinary globe valves are required, it is very easily repaired, only a screw-driver and a monkey-wrench being required to take it apart when necessary to clean or renew parts. It will be noticed that there is no valve or other obstruction in the overflow, so that when the injector is out of service, if the steam supply valve should leak, there is no danger of heating the water in the service pipe to a very high temperature. Fourteen sizes are made, covering a range of HP. from 2 to 400.—ADV.



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MACHINERY'S REGISTER.

Any employer or shop manager who is in need of efficient assistance, either in the form of a superintendent, draftsman, foreman or machinist, can be supplied with the names of the kind of men they need, from our Register. We will mail names of five men, with their qualifications and references, of the kind desired, on receipt of four cents in stamps to cover postage.